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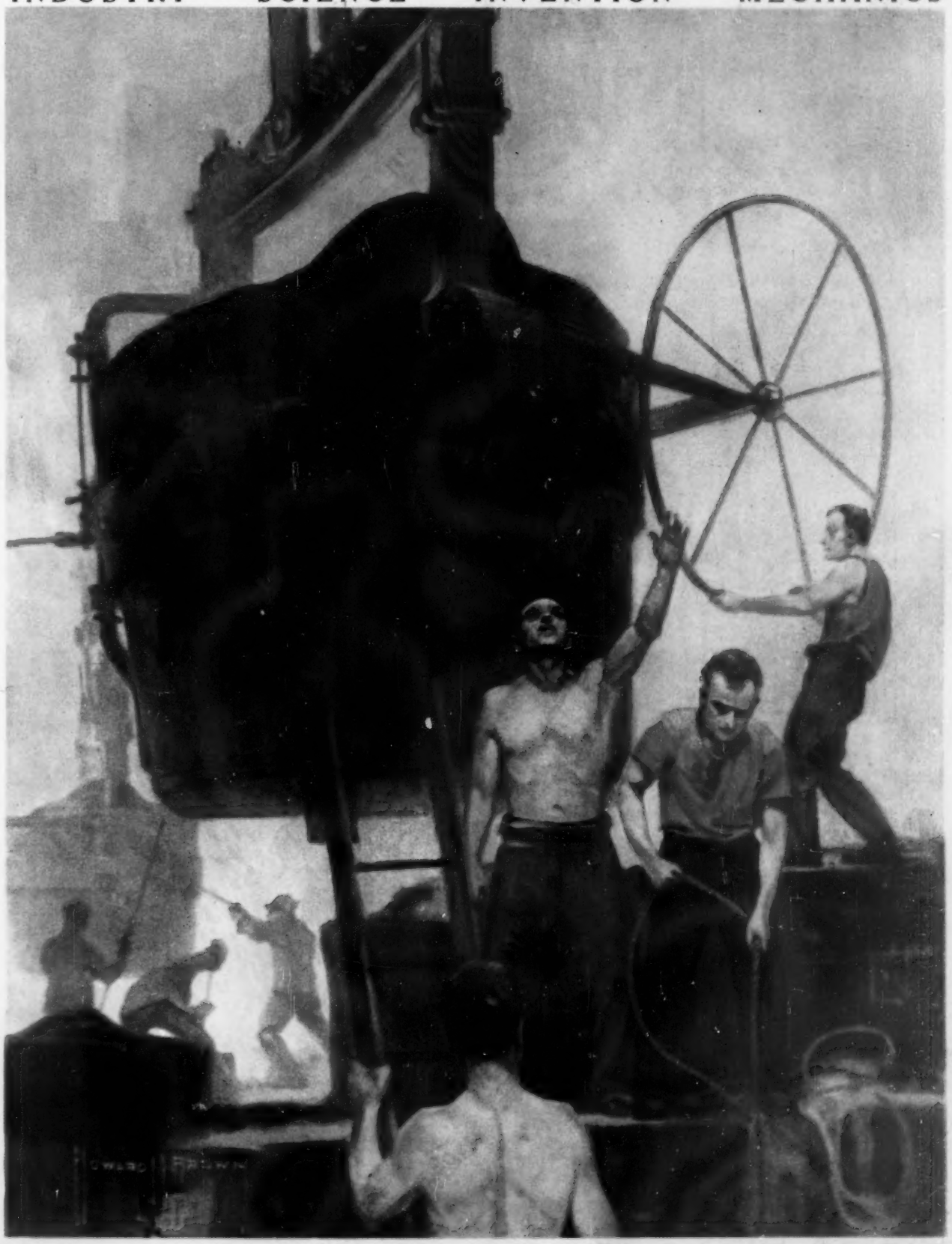
WHAT IS WRONG WITH OUR PAPER SUPPLY?
DULUTH TO LIVERPOOL IN ONE BOTTOM

SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS



TILTING THE LADLE IN THE FOUNDRY: AN ANCIENT ART IN A NEW DRESS

Vol. CXXII. No. 25
June 19, 1920

Published Weekly by
Scientific American Publishing Co.
Munn & Co., New York, N. Y.

Price 15 Cents
$5.00 a year

Entered as second class matter June 18, 1879, at the post office at New York, N. Y., under the Act of March 3, 1879

What shall I make it of ?

Not Iron or Steel—It must be strong, but it must not rust. Iron or steel would rust.

Not Copper—It must not corrode, yet it must have the strength of steel. Copper is not strong enough.

Not Lead—It must be immune to chemical action, but it also must stand up under grinding wear. Lead is soft and easily destroyed by friction.

Not Porcelain—It must hold a bright finish and be easily cleaned, but it must be unbreakable.

Not Bronze—It must be strong and resist corrosion, but it must also resist the erosive attacks of superheated steam and retain its strength at high temperatures. Bronze will not do this. Monel Metal will, and will also resist the corroding action of alkalies, salt water and most acids.

Make it of MONEL METAL—because this natural balanced alloy combines the best physical properties of other metals without their limitations. MONEL is as strong as steel, more corrosion-resisting than copper, more wear-resisting than bronze.

Products exposed to Rust—MONEL Metal never rusts—Window Screen is practically everlasting; Marine Equipment is unaffected by salt water; Automobile Fittings always stay bright.

Power Plant Equipment—MONEL Metal withstands the cutting wear of superheated steam—Valve Trim, Turbine Blading, etc., stand up and give more efficient service.

Chemical Apparatus—MONEL Metal defeats the attacks of alkalies and most acids and so is generally employed in manufacturing parts of Bleaching and Scouring Machinery, Dyehouse and like Industrial Chemical Equipment.

Parts subjected to High Heat—MONEL Metal retains its strength under high heat and resists oxidation; flame-exposed parts in Oxy-acetylene Torches, Pyrometers, Spark Plugs, etc., last longer.

MONEL Metal has also proved superior for special parts of mining, refrigerating, oil and gas machinery; for dairy equipment, kitchen fittings, table cutlery, surgical instruments, golf club heads, etc. No other available metal or alloy possesses such a wide range of usefulness.

The name MONEL is given to a line of metal products developed from a natural nickel alloy—67% nickel, 28% copper and 5% other metals. These products include MONEL rods, MONEL castings, MONEL sheet, MONEL wire, MONEL strip stock, etc.

MONEL Metal is a product of The International Nickel Company, widely known as the sole producers of *Inco* Nickel.

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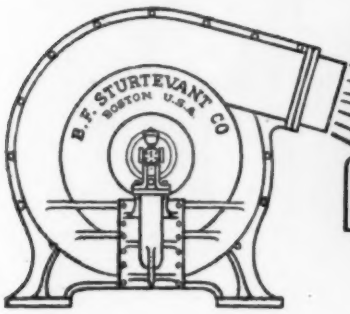

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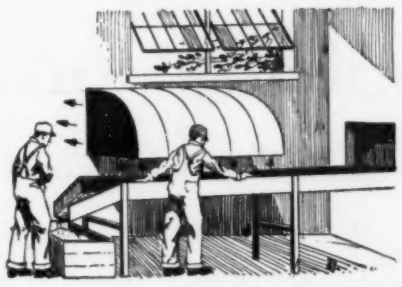
PUTS AIR TO WORK

The use of steam opened up a new world of invention. The control of electricity brought forth apparatus which is marking the twentieth century as an age of mechanical genius. In step with these giant strides is the development of Sturtevant air apparatus.

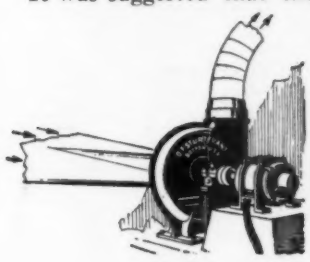
For more than sixty years Sturtevant equipment has been distinguished for its sturdy construction. Sturtevant machines have always done better work than other machines with the same ratings. The longer life and more efficient operation of Sturtevant products form a paying investment.

Air Makes Better Pop-Corn



While a Sturtevant engineer was working in a factory which turned out candied pop-corn he noticed the unsanitary and inefficient system of sorting the pop-corn. Girls sat close together, picking the fluffy, eatable pop-corn from the hard, imperfectly popped grains. The task was slow and the chances of spreading contagion among the buying public were many.

It was suggested that the pop-corn be sorted by air. Today the pop-corn is carried in on a moving screen above which a gentle current of air sucks—just strong enough to lift the light, eatable pop-corn, yet not strong enough to raise the heavier, imperfectly popped grains. A Sturtevant Air Conditioning System was also installed to remedy all troubles arising from excessive humidity.



Cleaning Oriental Rugs by Air

Standing unseen in the corner of one of those quaint shops which are loaded down with oriental treasures is a Sturtevant Vertical Stationary Vacuum Cleaner. The powerful suction from this machine cleans hundreds and hundreds of rare rugs—cleans them entirely by air, without the slightest danger of injuring them.

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These are only two ways Sturtevant puts air to work

Sturtevant Apparatus is very likely improving conditions and increasing profits in your own industry. If you will write, telling the nature of your business, a bulletin will be mailed which describes in detail the particular apparatus that can do some of your work. On special request, a Sturtevant representative will visit you at your plant. Address

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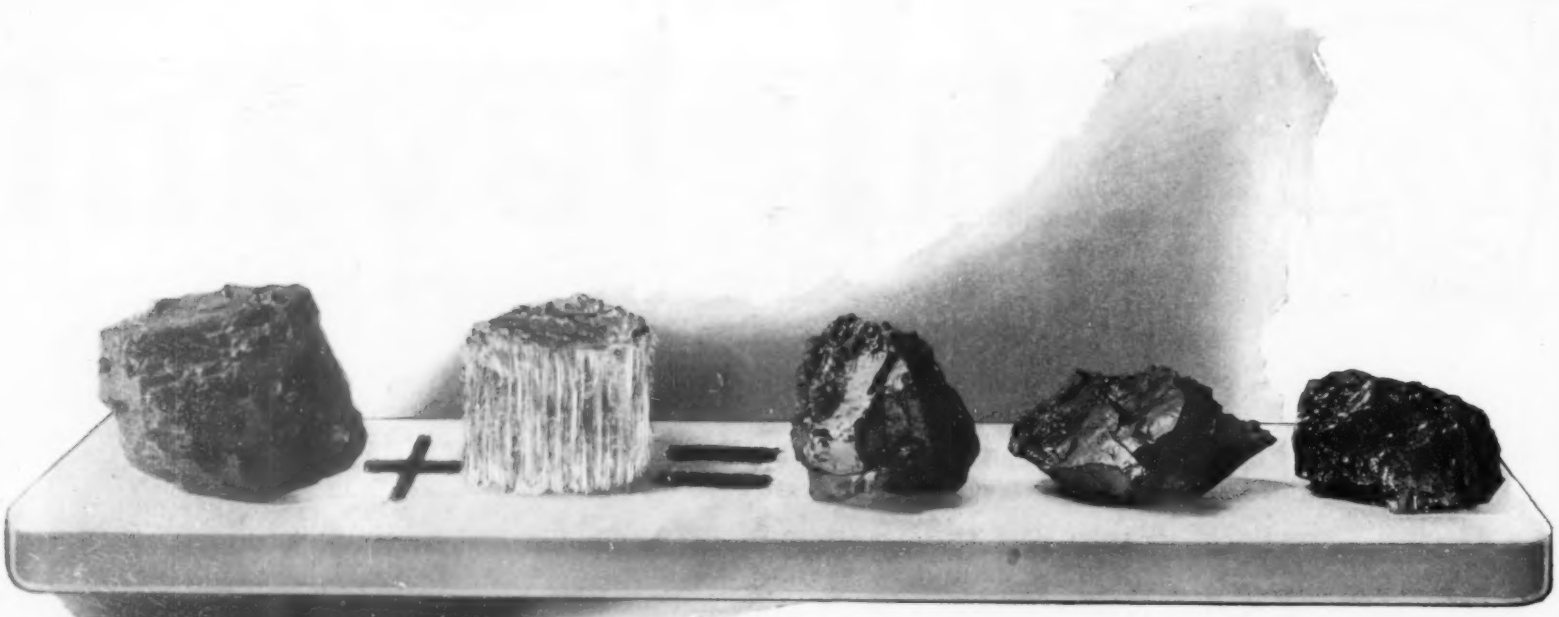

The proof that one plus one is more than two

IF every addition to the power output of America's industries called for a corresponding increase in fuel consumption, our boasted industrial progress would be a mammoth conceit.

A plant that can double its output only by doubling its fuel consumption adds far less than it should to the general wealth or to the bigger interests of those it serves.

Each year engineering contributes new devices, new methods and new knowledge that add to the great total of all technical knowledge and so tends to overcome the apparent necessity of applying twice the cause to get twice the effect.

Plants no longer need to double their coal bill to get twice the power. Roughly they less than double it and get twice the result, or they double the input and get better than twice the output—not by burning more fuel wastefully, but by cutting fuel losses through insulation knowledge and materials.

Johns-Manville Asbestos in its wide usage in heat insulation has become a great ally to fuel, in accomplishing this. Nor does its use stop there, for in various combinations with allied materials it furthers plant efficiency, in packings that prevent leakage and prevent friction and again in high-heat cements so necessary to boiler furnace operation. More and more as knowledge gains, Asbestos becomes the bodyguard of fuel through products like these:

Asbestos and 85% magnesia insulations for steam and hot water piping; Aertite Boiler Wall Coating for boiler wall exteriors; High Temperature (Refractory) Cements for boiler settings; Asbestos Sheets and Blocks for insulating hot surfaces; Insulating Cements; Monolithic Boiler Baffle Walls—tight, durable, easy to install—prevent short-circuiting of hot gases; Sea Ring Packing—eliminates unnecessary friction between rod or plunger and packing.

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that keeps the heat where it belongs
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that make brakes safe
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JOHNS-MANVILLE
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SEVENTY-SIXTH YEAR

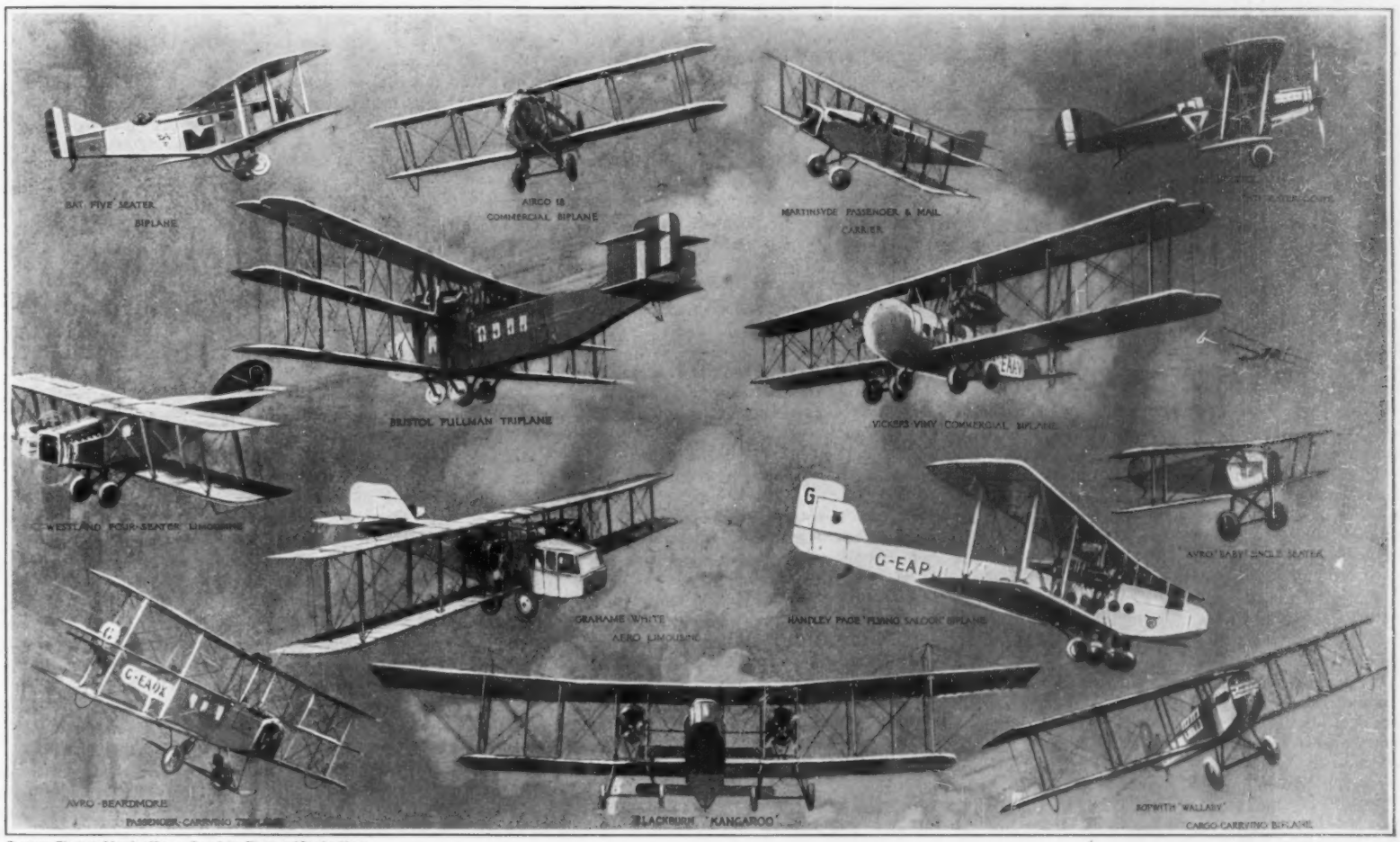
SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXXII.
NUMBER 25]

NEW YORK, JUNE 19, 1920

[15 CENTS A COPY
$5.00 A YEAR



Courtesy, Illustrated London News. Copyright, Illustrated London News

Leading types of British airplanes now being used for civilian flying in Great Britain and on the Continent, both for regular passenger service and for private use

Forerunners of the Flying Liners

WONDERFUL as is the progress in air travel, still greater developments are predicted. According to Harry Harper, Technical Secretary of the Civil Aerial Transport Committee of Great Britain, designers now turn their thoughts to machines they can produce when they are given, as they will be soon, motors developing 1,000 horsepower. If business men make a regular and sufficiently increasing use of Continental airways, one can foresee already a twenty-five dollar fare between London and Paris.

It must be admitted, in all fairness, that Great Britain has forged ahead in the matter of civilian aviation faster than any other nation. The United States is lamentably behind times, despite the heroic efforts of companies and individuals here and there to try to stimulate interest in peacetime flying. In Great Britain civilian flying is already pretty thoroughly established, although it is admitted that with the present-day types of machines much remains to be desired before aerial carriers can hope to compete with ground and water carriers in the matter of regularity of performance and low cost.

The accompanying drawing, for which we are indebted to the *Illustrated London News*, depicts the various types of machines now being used in Great Britain for civilian work. The following additional facts regarding these various machines may be of interest: Airco 18 (engine, 450-horsepower Napier; 8 passengers, besides pilot; speed, 120 miles per hour). Avro "Baby," Type 534 (40-horsepower Green; pilot only; 77½ miles per hour). Avro five-seater, Type 547 (160-horsepower Beardmore; four passengers; 75-90 miles per hour). B. A. T. "F. K. 26" (350-horsepower Rolls-Royce "Eagle VIII."; 4 passenger; 120 miles per hour). Blackburn "Kangaroo" (two 250-horsepower Rolls-Royce "Falcon"; 9 passenger; 92 miles per hour). Bristol Pullman Triplane (four 410-horsepower "Liberty"; pilot, engineer and 14 passengers; 125 miles per hour). Bristol Tourer (240-horsepower Siddeley "Puma"; 1 passenger; 115 miles per hour). Grahame-White Aero-limousine (two 320-horsepower Rolls-Royce "Eagle V."; 4 passengers; 100 miles per hour). Handley-Page W. 8 "Flying Saloon" (two 450-horsepower Napier "Lion"; crew 2, passengers, 15-18; 115 miles per hour). Martinsyde (275-horsepower Rolls-Royce; 2 passengers; 123 miles per hour). Sopwith "Wallaby" (375-horsepower Rolls-Royce "Eagle VIII."; 6 passengers; 118 miles per hour). Vickers-Vimy Commercial (two 350-horsepower Rolls-Royce "Eagle VIII."; 16 passengers; 115 miles per hour). Westland Limousine (275-horsepower Rolls-Royce Falcon III.; 3 passengers; 90 miles per hour).

We in the United States have several types of planes which compare favorably with the British types here shown. The Lawson air-liner, with its capacity of 26 passengers, is a practical plane for commercial use. Then there is the Curtis "Eagle," which carries eight passengers and which represents, so some experts tell us, the ideal sized unit of aerial transportation. The Glenn Martin twin-engined plane, which proved an excellent bombing type machine for warfare purposes, is another example of practicul American airplane for civilian use.

Cleaning a Clock

WHEN a clock stops it is a mistake to suppose that it must at once be taken to the workshop for repairs. In most cases clocks cease running because of the accumulation of dust particles which clogs the bearings. It is not even needful to take the clock to pieces to clean it if a simple plan is followed which will be found to work very well. Soak a piece of cotton wool in kerosene and place this in a small saucer, a canister lid, or anything similar. Then put this in the case of the clock under the works. Close up, and at the end of twenty-four hours, examine the cotton wool. It will be found to be covered with black specks; these are the dust particles brought down by the fumes of the kerosene. Wind the clock up and it will start away again. Where the works of the clock are in an enclosed case a few drops of kerosene should be poured through the small hole which is present in the metal covering. Turn the clock about a while so that the kerosene is distributed and after an interval, it is extremely likely that the works will commence their normal operations again.

SCIENTIFIC AMERICAN

Published by Scientific American Publishing Co.
Founded 1845
New York, Saturday, June 19, 1920
Munn & Co., 233 Broadway, New York

Charles Allen Munn, President; Orson D. Munn, Treasurer
Allan C. Hoffman, Secretary; all at 233 Broadway

Entered at the Post Office of New York, N. Y., as Second Class Matter
Trade Mark Registered in the United States Patent Office

The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Should the Secretary of the Navy Be a Civilian?

WE believe that there will be a general agreement among thoughtful men that Mr. Daniels's career as Secretary of the Navy will have served a very useful purpose in showing any future President the need for a most discriminating choice in selecting a secretary for the Navy. We say this dispassionately, and without any personal prejudice against the present occupant of that extremely important post. What we mean is that, in the two fundamental essentials for a Secretary, namely, a fair working knowledge of the material side of the Navy and a highly sympathetic appreciation of the spirit and traditions both of the officers and of the men, Mr. Daniels, when he took up his present position, seemed to be seriously lacking.

It is impossible for a Secretary to discharge the duties of his office without gaining, as years go by, a working knowledge of the material side of that most complicated organization known as the Navy, and this, no doubt, the present Secretary has done. We had hoped that he would have grown also to a better appreciation of the high code of ethics which is instilled into our young men at Annapolis, and is fostered and strengthened by actual service on board ship, or in the various tasks and associations entailed during shore duty; but we are free to confess that the whole attitude of the Secretary during the recent Congressional investigation, in which so large a part of his effort was directed to personal attack upon what he conceived to be the idiosyncrasies of two of the most distinguished admirals in the United States Navy, seems to show that he is as far from understanding the high character, lofty professional aspirations and unselfish devotion of the officers of our Navy to the Service, as he was when he first took up his office.

The question as to whether it would not be advisable to appoint a naval officer and not a civilian to the office of Secretary of the Navy is very much in the air these days; and there can be no doubt that the failure of Mr. Daniels to recognize the unpreparedness of the Navy prior to the war, and his attitude towards the officers who were most frank in pointing out the defects of the Navy, coupled with his recent virulent attack in the Senate investigation, has had much to do with raising this question.

Let it be said here and now that we believe that, however desirable it might be, from the technical side, to have a naval officer as Secretary, there are other and more weighty reasons which render it necessary for the Secretary of the Navy to be a civilian—an opinion with which we believe the majority of the rank and file of the Navy would be found to be in agreement. What we wish to point out and emphasize with all our power, is the necessity for making a more discriminating choice in selecting a civilian for this office. Unquestionably, he ought to have a more than average knowledge of naval affairs, and preferably he should be a man who has acquired this knowledge as the result of a natural inborn interest in the subject. There are many civilians, even among the politicians, who have this qualification, and we have always considered that it was a thousand pities that the present Assistant Secretary of the Navy, Franklin D. Roosevelt, was not selected for the post. Not only has Mr. Roosevelt always been a close student of naval matters, but he is temperamentally and by character well-fitted to understand that *esprit du corps* both in officers and in men which stood at such a high level in 1912. There would have been a memorable precedent for this selection: for the position was once filled by a Roosevelt whose intelligent and forceful administration, due to his special fitness for the task, marked an epoch in the advancement of our Navy.

The policy of selecting a Secretary merely on the grounds of faithful political service to his party is extremely pernicious, and, in our opinion, the Navy has suffered greatly from this practise. Whichever party may come into power next year, there will be found in its ranks not one, but several men (notably in the Naval Committees), who have a natural aptitude for naval affairs, a thorough knowledge of the past history of the United States Navy, and a full appreciation of the importance of maintaining the morale of the Service by upholding the dignity of the ranking officers before the enlisted men, while at the same time doing everything possible to better the enlisted man's condition. It is in the last regard that Mr. Daniels has done his best work in the Navy, and every credit is to be given him for this; but we cannot but feel that his recent exhibition before the Senate Naval Committee was most unfortunate from whatever point of view we regard it.

The Proposed St. Lawrence Ship Canal

THERE are some great works of engineering whose execution sooner or later can be confidently predicted—so obviously useful and so ultimately necessary do they appear. Among works of this character we may mention the Panama Canal, the Trans-continental Railroads, and the provision of an adequate system of good roads.

The only elements of doubt concerning such works are those attaching to the questions of traffic and finance—just as soon as there is sufficient passenger and freight traffic in sight and the necessary capital for construction, great engineering works of this character are entered upon and pushed steadily to completion.

Holding a commanding position among prospective works of this character, is the proposition to open up a water-way for ocean-going steamers from the Great Lakes to the Atlantic by way of the St. Lawrence River, as very completely unfolded in an article which will be found upon another page of this issue. Great and costly though the enterprise may be, it is entirely feasible from the standpoint of the engineer. There is nothing in the plan or scope of the enterprise which goes beyond well established engineering precedent, or calls for constructions that are experimental, and regarding whose ultimate cost there is any serious doubt. The opening of this great water-way by canal, canalized river, and deepened channel, thereby enabling a deep-sea ship to load at Duluth and not break open her hatches until she reached Hamburg, London or Marseilles, is as certain of being taken in hand today, or at some future day, as that the sun will rise tomorrow.

Because of the joint ownership of the St. Lawrence, it is probable that this enterprise will be put through by the combined efforts of the United States and Canada; but before the people of the State of New York are led to invest their capital in this St. Lawrence scheme, they should realize that they have a canal of their own from the Lakes to the sea which has the first call upon their interest and effort. Already the State has expended $150,000,000 upon this enterprise, which now requires only the proper terminal facilities in the way of grain elevators and up-to-date wharfage accommodation, to enable it to handle a large share of the freight which passes from the St. Lawrence to the Atlantic seaboard. The State Legislature has made appropriations for certain terminal works, but there is a call for further appropriations for the necessary grain elevators at Buffalo and New York. With these elevators in operation independently of railroad control, for the benefit of any users of the Canal, we predict that the State Barge Canal will experience a rapid return to its former prosperity, if indeed, the total tonnage carried does not greatly exceed any previous record.

Port and Manufacturing Center Combined

EVERYBODY knows that New York is the leading port of the United States; but not everyone knows how great it is as a manufacturing center. A United States census bulletin of the year 1905 showed that over 55 per cent of the population of this city was then engaged in manufacturing, and the total value of the production was given as 10 per cent of all the manufactured products of this country and greater even than the total value of the foreign commerce of that date. That was fifteen years ago, and the city has now grown to a total population of 5,621,151, so that what the present census will reveal as to the manufacturing business of this city must be left to conjecture. Unquestionably, there has been a very great increase.

What we wish to draw attention to just here is the fact that in order to bring in the raw materials for this activity and take out the finished products, it is necessary to provide most elaborate transportation facilities, especially in the very heart of this industrial center, Manhattan Island; and in addition to all this is the large export and import business by way of New York. Now, the most congested center for all this freight movement is to be found on the North River water front of Manhattan. So valuable is space here that companies pay as high as over $100,000 per annum for pier rental; and if you consult the files of the Dock Department, you will find a large number of applications from steamship companies who are unable to get dock accommodations, no matter what price they offer.

Therefore, it logically follows that whatever comprehensive scheme for the organization of the whole Port of New York is adopted, first attention should be given to this Manhattan water front, particularly as regards its facilities for the handling of freight. We do not mean by this that the reorganization of the Manhattan water front should be taken up at once and independently; but we do consider that, once the general scheme has been outlined, efforts should be concentrated at once upon the construction of the needed improvements at this point.

Just how bad conditions are may be judged from the fact that from Pier 1 at the Battery, to Pier 42, on the North River, a total distance of 9,765 feet, the railroads occupy for their exclusive service, 4,930 feet, or 55.4 per cent; the ferries occupy 1,087 feet, or 11.2 per cent; which leaves only 3,748 feet, or 38.4 per cent of the water front for its proper service, which should be the accommodation of river, coastwise and overseas shipping.

The removal of the downtown freight terminal of the New York Central Railroad to the Harlem District, and the construction of sufficient bridges and tunnels across the East River would release over 55 per cent of the Manhattan water front for shipping. With this improvement would go the construction of an elevated marginal railroad down West Street, with spurs running out on to the piers on the river side and into large terminal warehouses on the east side of the street.

Although the problem of the Manhattan side of the North River water front presses most urgently for solution, it is merely the heart of the greater problem of the reconstruction and development of the great port itself, with its hundreds of miles of water front, and the hinterland lying back of it. This question is so big and involves so many hitherto conflicting interests that the only hope for its solution lies in the whole-hearted coöperation of the many interests concerned. It is to secure this harmonious coöperation that bills have been introduced in the Legislature both of New York and New Jersey having for their object the establishment of an Interstate Port Authority for the control of the whole port of New York. This is to consist of three members from each state. Of the New York representatives, two must come from New York City, and New Jersey must have two from the port section of that state.

This is not a new thing; for the plan has been under consideration by the New York-New Jersey Port and Harbor Development Commission for the past two years. We do not know just now of any great public work that we can more strongly commend to the sympathetic interest and active endeavors of the citizens of the two states than this.

Naval and Military

New Use for Range Finders.—A new use for range finders has been suggested. The possibility of turning these devices, so extensively used during the war, to practical use in times of peace in connection with coast navigation work is believed possible. An endeavor is made by a prominent scientist to demonstrate that this instrument could, at least within certain district limits, compare favorably with the instruments up to now exclusively made use of in the regular practise of navigation in sight of land.

Size of the French Army.—According to dispatches from Paris, France, in accordance with the recommendations of Marshal Foch that she maintain a large army, at least for the immediate future, has decided to maintain an army of a million men until there shall be assurance that the number may be reduced. At the present time, there are about 800,000 men in the army. The new class will number about 300,000, and about 120,000 who have completed three years' service are about to be discharged.

Our Field Artillery Personnel—In view of the growing importance of artillery in warfare, it is gratifying to know that in the five months, November 30, 1919, to April 30, 1920, the strength of the Field Artillery regiments was increased from 7,366 to 12,000. In the case of only one regiment, the First, stationed at Fort Sill, was there a decrease in strength; the Fifth Regiment, at Camp Zachary Taylor, showed the largest gain, its strength increasing from 232 to 987. Evidently the Field Artillery is popular, for during the same five months, while the percentage of all army enlistments was 16.2, that of the Field Artillery was 51.6.

Director-Control on the "Tennessee."—For the first time, so far as we know, the Navy Department has given out a general statement regarding the installation of director-firing apparatus on our warships. The "Tennessee," which recently went into commission, has the new system by which the elevation and traversing of the guns can be controlled from a director station at the top of the foremast. The system insures the accurate and simultaneous control of the guns by an officer located at this point. Should the station be shot away, control can be exercised from various other point in the ship. The details are withheld, of course; but it is sufficient to say that the ship's battery can be held upon the enemy, whose changes of course and range are instantly known and recorded.

The Future of the Submarine.—In a paper read by W. S. King-Hall, R. N., at the Royal United Service Institution in London, the author stated that any advantage possessed by the submarine over other ships of war is on the wane. The advantage of the submerged ship has fallen from nine to one against the surface ship in 1914 to seven to three in 1919, and it is likely to be only six to seven by 1930. It is his belief that the development of submarine detecting apparatus will give large ships a certain measure of protection against tactical attack by submarines. The capital ship will continue to be a surface vessel, and the idea of making her a partially submersible ship has been abandoned. He believes that the smaller types of vessel might be given a certain degrees of submersible quality, particularly for the work of reconnaissance.

A Suggestion for Naval Policy.—Commander H. J. M. Rundle, of the Royal Navy, Retired, in an article in the *United Service Magazine*, summarizes his conception of the naval requirements of the future for Great Britain, as follows: A small highly efficient regular Navy, capable of rapid expansion in emergency; local defense organizations of the various dominions and dependencies; an auxiliary service, including local defense organizations in home waters; efficient staff work, combined with constant experiment and research; considered plans and arrangements for the rapid expansion of the fighting forces and the provision for types of vessels for auxiliary and subsidiary purposes, without throwing undue strain on the resources of the mercantile marine; and, finally, a thorough appreciation of the character that future wars are likely to assume, such appreciation undergoing constant examination and revision as the course of events progresses.

Science

The Sun as a Source of Power.—In a recent paper on this subject, Mr. C. Le Roy Meisinger records that in certain subtropical regions, where coal is scarce, such as Egypt, the Punjab, and the Karoo of South Africa, teakwood boxes, blackened within, fitted with glass tops and properly insulated, have been found to register from 240 to 275 deg. Fahr. in the middle of the day, and, with the addition of an auxiliary mirror, to reach even 320 deg. These boxes are used as ovens for cooking, as well as for many other purposes.

The International Council for the Exploration of the Sea, which has gathered so much valuable information in behalf of the fisheries of the North Atlantic, held its first meeting since 1913 in London, March 2-6 of this year. Great Britain, France, Belgium, Holland Denmark, Sweden, Norway and Finland were represented by two delegates each, in addition to scientific experts from the fishery authorities of each country. Germany and Russia, formerly prominent in this work, were not represented. Extensive programs of study and exploration were adopted. The next meeting is to be held at Copenhagen in 1921.

The Physics of the Air.—With the recent publication in the *Journal* of the Franklin Institute of a paper in two installments on "Factors of Climatic Control," Dr. W. J. Humphreys has completed a series of papers that he has been publishing for more than two years in the journal above mentioned on the general subject of "Physics of the Air." It is expected that this work will soon be issued in book form. No first-rate comprehensive book on meteorology written from the standpoint of the physicist exists, at present, in any language. and there is perhaps no more striking gap in the literature of science. Dr. Humphreys's book will go a long way toward filling this gap. It is especially remarkable for the amount of skill and labor the author has devoted to checking, verifying—and in many cases discrediting—doctrines and ideas that have heretofore been passed on from one meteorological writer to another without critical examination.

Dyes for Photographic Plates.—At the last meeting of the American Astronomical Society, Miss Florence J. Stocker reported on the progress made by American chemists in producing dyes for use in sensitizing photographic plates to various portions of the spectrum. The dyes used in sensitizing to the green, red and infra-red are of the types known, respectively, as pinaverdol, pinacyanol, and dicyanin. The U. S. Bureau of Chemistry has produced a pinaverdol which is somewhat superior to any German or English green sensitizer, and a pinacyanol which is practically the same as German pinacyanol and English sensitol red. The same bureau has produced several dicyanin dyes which are only slightly inferior to those of German make. Recently the Bureau of Chemistry has submitted to the Bureau of Standards for testing a new type of dye, called kryptocyanin, a sample of which has been found to give a very pronounced narrow region of photosensitivity from 7200A to 7700A. This may prove of great importance for spectrum photography.

Acoustic Aids to Navigation.—We are told by Commander C. S. McDowell in an article in the *U. S. Naval Institute* that there has probably been more learned about sound and its transmission during the past four years than during all the rest of time. Listening devices installed outside the ship's skin, or within ship's tanks, not only distinguish different sound sources at considerable ranges when the ship is under way, but the direction can be obtained within an accuracy of two or three degrees. He instances the multiple-unit microphones with electric compensator placed on the "Von Steuben," which were placed both inside ship's tanks and also within a blister outside the ship's hull. We are told that on the "Von Steuben," when running at full speed, the submarine bell on Nantucket lightship was heard at a distance greater than thirty-five miles and accurate bearings obtained. He tells us that it may be safely stated that a distinctive sound source, as a submarine oscillator, can be heard at all times, and during all kinds of weather in deep water, at a distance of 20 miles or more. In addition to obtaining bearings of distant sound sources, these devices may be utilized to determine fairly accurately the depth of water.

Electricity

Naval Searchlights.—A general résumé of the position of the searchlight in the United States Navy recently appeared in the Proceedings of the American Institute of Electrical Engineers. The different sizes of lights are described and their respective advantages and disadvantages are detailed. The high-intensity arc is described in detail, and in a 24-inch projector is said to have a range of 8,000 yards as against the 2,000-yard range of the 30-inch and 36-inch projectors using the plain carbon arc. The blinker lamps for naval signalling, and the Aldis daylight signalling lamp are also described and illustrated.

A New Type of Storage Battery of Swedish origin is described in a recent issue of *Science Abstracts*. This new battery appears to be a modification of the nickel-iron alkaline cell as made by Jungner, the chief characteristic being the method of making up the plates from briquettes of active material, which are automatically fed in between two perforated nickel-steel strips. These strips enclosing the active material are manufactured in lengths folded together and fitted into a steel frame. The complete electrode is then put through a rolling process to ensure perfect contact between the active material and the strips. Only a brief indication is given of the methods followed.

Direction Finding by Radio.—A method of compensating the minimum and increasing the accuracy of direction-finding settings has been worked out for long waves. It has been shown that deviations of the order of 90 deg. may occur in the line of propagation of the resultant wave front in the case of very long continuous waves. The value of long continuous waves for direction-finder work is, in view of these results, very doubtful. It is said that the results do not cast doubt upon the accuracy of direction-finder observations carried out on short-wave-spark stations. It must be concluded, however, that it would be very dangerous to use long continuous waves for direction-finder work at sea until it has been definitely proved that these variations do not occur when transmission is not partly or wholly over land.

An Artificial "Track Circuit."—The extensive use of the track circuit in railway signalling has created a need for an artificial "track circuit" to reproduce the electrical properties of the real one to be used in research and test work. The track circuit, we learn from *The Electrician*, is formed by isolating a section of the running rails forming part of a relay circuit so arranged that auxiliary circuits operating signals and so on are controlled by the presence of a train in the section. The artificial "track circuit" is made up so as to imitate the electrical conditions obtaining in practise, and is controlled by four switch dials, each with a number of studs whereby the four components of the branches of the artificial circuit can be regulated. To test any type of track apparatus the arrangement can be fitted up in the laboratory with the artificial track circuit set to any value of rail impedance and ballast admittance, and the effect of a "train shunt" can be investigated at either end of the track. The rail constants on the actual track circuit can also be measured.

Aerial Characteristics. The Bureau of Standards has published Scientific Paper No. 354 on the above subject, copies of which may be had from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each. The functioning of the two principal types of radio aerials is worked out quantitatively from fundamental electromagnetic theory. Experiments have verified the formulas and conclusions presented. Formulas for the current received in either antenna or coil aerial in terms of current in either type of transmitting aerial are given, as well as comparison formulas giving the relative performance of antenna and coil aerials under various conditions. The advantages of the condenser type of aerial are presented. The theory and nature of radiation are discussed and applied to the elucidation of some current fallacies. The basic principles of design of aerials are given and desirable lines of future research are pointed out. The use of the coil aerial as a direction finder, interference preventer, reducer of strays and submarine aerial are not among the subjects treated.

Duluth to Liverpool in One Bottom

The Arguments Advanced in Favor of a Deep-Water Route Between the Great Lakes and the Sea

By Robert G. Skerrett

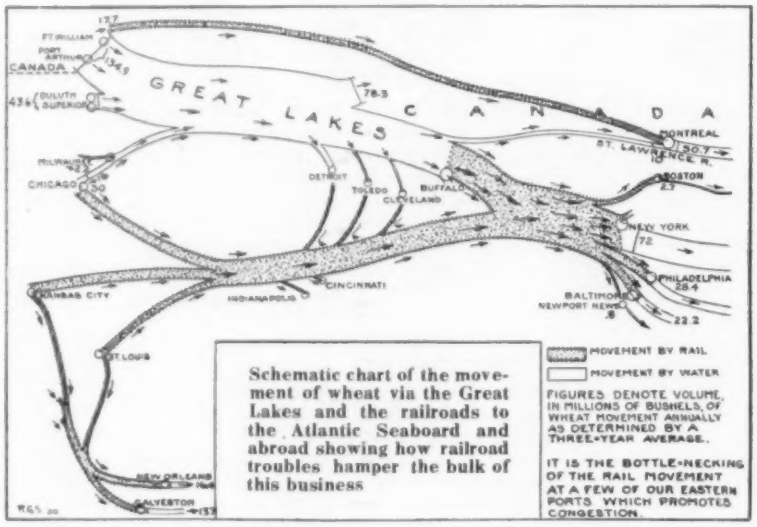
THE measure of our productiveness, the prompt distribution of our multiple commodities, and the satisfying of a restless public, hinge in large measure upon the expeditious movement of our tremendous and steadily increasing volume of freight. The tide of this traffic is today distressingly slowed up by reason of the demoralized condition of our railways, and it is inevitable that we find other means of distribution so that the tide of foreign and domestic commerce may be brought to a state of equilibrium.

We cannot achieve this vital end—a goal which is profoundly linked with the nation's well being—unless we bring the vast industrial areas of the West and the Middle West within easier touch of the seaboard. The citizenry of other divisions of the country seldom realize the economic significance of the States bordering upon or tributary to the Great Lakes.

In certain phases of agriculture, meat packing, dairy products, manufactures, and mineral yields, the total for the United States six years ago amounted to $29,398,414,000, while the group of interior States just referred to furnished nearly 40 per cent of this magnificent sum. And this is only the beginning of the story; a few of the details will make it clearer how much of a treasure house this region really is. Occupying but one-third of the national area, its wide-awake population produces something like seven-eighths of our principal staples, exclusive of cotton and tobacco. Upon its fertile fields are 75 per cent of our wheat; 65 per cent of our corn; substantially all of our flax; half of our potatoes and sugar beets; 50 per cent of the country's cattle, dairy cows, and swine; 60 per cent of our horses. From the mines in these States come 85 per cent of our iron; 39 per cent of our copper; 74 per cent of our zinc; 46 per cent of our lead. And the geologists tell us that quite 72 per cent of our measured coal reserves lie within this favored zone.

The stimulus of the recent conflict did much to augment many of the foregoing figures; and now as a people we must either help ourselves by helping those States to continue at their present productive pace or we shall have to see them slump as a source of stupendous economic power. In a large sense the future of this section and the welfare of all of us depend upon the Great Lakes being opened to the sea so that ocean-going craft can steam from Duluth to the Atlantic and thence along our neighboring seaboard or afar to the markets of Europe. A deep-water route of this character, ample enough to float laden craft of drafts from 20 to 25 feet, would accommodate the great majority of the existing ocean steamships.

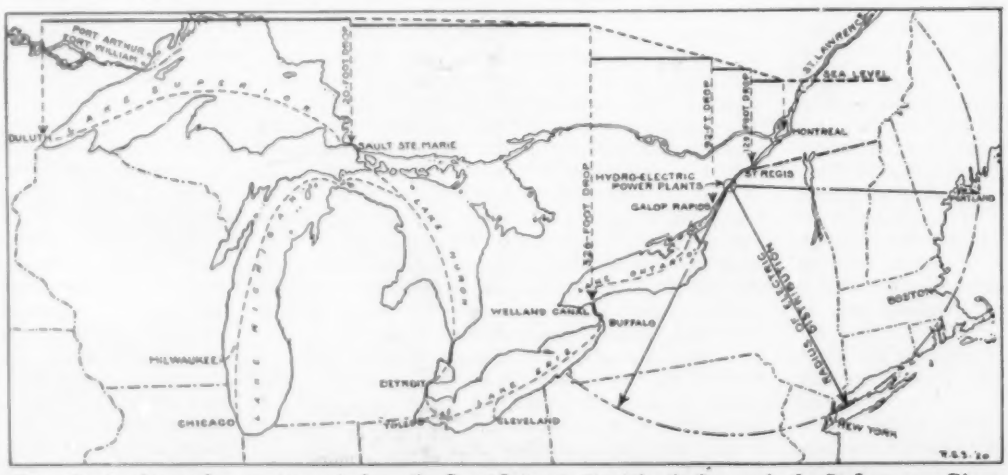
This splendid project has been agitated at intervals during the past two decades and more, and the probable cost would be trifling in comparison with the immediate and prospective benefits to be realized. Indeed, the entire outlay for us, including the deepening of present channels through the Great Lakes and tributary to the cities thereon, would probably not equal one-fourth the sum we gladly subscribed to build the Panama Canal; and the gains in some respects would be much bigger at the very start than those now reaped by us through the agency of the Isthmian waterway. Thanks to the enterprise of neighboring Canada, the problem broadly reduces itself to submerging certain rapids lying in the international waters of the St. Lawrence River between Lake Ontario and the Indian village of St. Regis, and then dealing in a similar way with that stretch of the river extending from St. Regis to Montreal, which would involve, incidentally, the work of flooding the Lachine Rapids.



Schematic chart of the movement of wheat via the Great Lakes and the railroads to the Atlantic Seaboard and abroad showing how railroad troubles hamper the bulk of this business

THE proposal to build a deep-water route between the Great Lakes and the sea has been before the public for many years. When the scheme for relocating and deepening the Erie Canal was being agitated, a strong movement developed for an alternative plan, which contemplated the construction of a 25-foot ship canal from Lake Erie to the Hudson, and the deepening of that river, so as to permit the carriage of freight to New York, or direct to European ports, without rehandling. That would have been an all-American undertaking. The present scheme for deepening the St. Lawrence would be a joint Canadian and American effort. Ultimately the State Barge Canal was adopted as preferable to a ship canal. It has been completed at a cost of over $150,000,000; but for want of suitable terminals and grain elevators it is, as yet, carrying only a small proportion of its full capacity. The State authorities believe, and we agree with them, that until the State Barge Canal has been completely equipped, the efforts of New York State should be directed toward putting its own $150,000,000 investment into first-class operating condition. However, in view of the present active agitation of the question, we present Mr. Skerrett's statement of the scope and purpose of the proposed St. Lawrence improvement.—THE EDITOR.

By quite 500 miles and yield hydro power for distribution over a wide radius from the dams



Map showing how a deep-water route from the Great Lakes to the Atlantic Ocean via the St. Lawrence River would shorten a voyage to Great Britain or Northern Europe by quite 500 miles and yield hydro power for distribution over a wide radius from the dams

Today the Canadians are enlarging the Welland Canal so that the roomiest locks will be 1,000 feet long, 80 feet wide, and have a depth of 30 feet of water at the lowest level of the river. This work was slowed up by the war, but is now being pushed energetically and should be finished in the course of four years at a total expenditure of $75,000,000. From Galop Rapids to St. Regis, a distance of about 115 miles, the St. Lawrence drops 92 feet, and sufficient water for deep-draft vessels can be obtained by building across the international stream a series of dams which would convert the areas now occupied by rapids into a number of navigable slack-water basins. In these dams there would be formed numerous locks so that steamers bound up or down could thus pass from level to level while threading the broad channel of the modified St. Lawrence.

From St. Regis on to Montreal, a run of 68 miles, the St. Lawrence has a fall of 129 feet, and of this stretch 46 miles are now plain sailing with plenty of deep water. The engineering task here would involve the rearing of dams at suitable points across the river to flood the shallows and rapids in about 22 miles of travel. This part of the scheme would rest upon Canada, inasmuch as that section of the river lies wholly within her domain. The river will not be canalized in the usual sense of the term; the submerged rapids would afford broad channelways along which steamers could proceed at full speed. Traffic would be slowed down only when using the canals interposed between Lake Superior and Lake Ontario or when changing level in going through any of the locks. This celerity of movement will mean much toward making it profitable to operate ocean-going freighters over the projected route.

In June of last year, the Lake Grandby, an American freighter, 251 feet long, 43½-foot beam, and of 1,605 net tonnage, sailed from Chicago with a cargo of meat destined for Liverpool. She was the first of a fleet of 15 craft built by the United States Shipping Board and intended for this traffic. However, because the St. Lawrence canals now limit the draft to 14 feet, the Lake Grandby cannot start from her Lake port full laden—she takes on more cargo at Montreal. This means that when returning from abroad she must also discharge part of her freight at the Canadian port in order that she may steam on to Chicago. With the enlarged Welland Canal available, and with the contemplated dams and their great locks built, big cargo carriers of many thousands of tons could traverse the whole length of the St. Lawrence to and from Lake Erie; and with improved facilities at the Soo and deeper channels through the Lakes here and there, Duluth, Superior, Milwaukee, Chicago, Detroit, Toledo, Cleveland, Buffalo, etc., would have an unhampered outlet to the ocean.

As those familiar with the subject know, vessels laden with wheat bound from Duluth, Chicago, etc., generally break bulk at Buffalo, and the grain is then dispatched by rail or canal to New York, Boston, and Philadelphia on its journey to consignees over-

(Continued on page 686)

What Goes On Inside a Gas Cylinder

IT is a simple matter to take an indicator card of a steam engine. The apparatus for doing this is familiar, and the principles upon which it is built and operated date back to the time of the immortal James Watt. Naturally, in the development of the gas engine, engineers wished to apply the indicator to this new prime mover; but the question of how to do it proved very formidable. An apparatus which functioned very well in an engine running from one hundred to two or three hundred revolutions a minute and using pressures that rarely exceeded a maximum of two hundred pounds to the inch, could not be applied to the internal combustion engine, with its enormous maximum pressures, its wide range of pressure, and its speeds of revolution that run up to three thousand per minute or even more. The illustrations which accompany this article show a beautiful solution of the problem by the engineer whose name the Midgley Indicator bears. We had the pleasure of seeing one of these in operation recently at the laboratory of the Dayton-Wright Airplane Company.

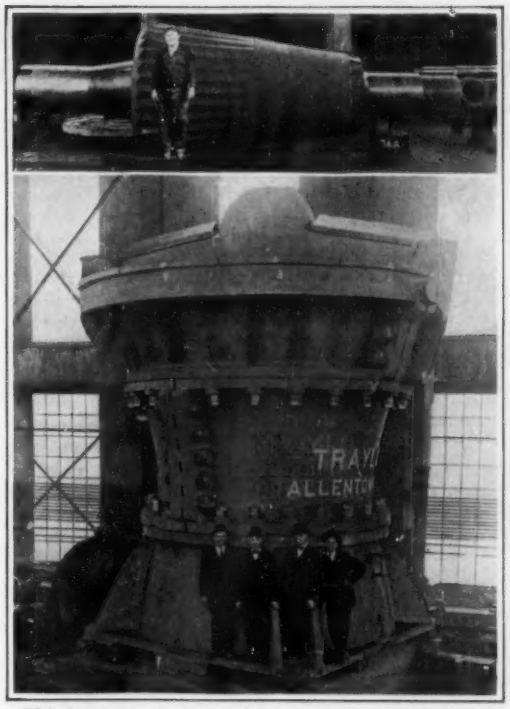
The indicator is composed of two separate units, one of which is connected to the rotating parts of the engine, the other to the combustion chamber of one of the cylinders; the first giving a record of speed and the other of pressure and the two being ingeniously combined in their effect, through the medium of a beam of light, so as to produce a luminous indicator card.

Briefly stated, the luminous diagram is produced by means of a pencil of light and two movable mirrors, the first recording the changes of pressure, and the second the travel of the piston.

The system comprises a six-volt light bulb, *A*, which is used as the source of light; a motor box, *B*, which is supported by a bracket, *C*, clamped to the cylinder to be tested; a concave rocking mirror, *D*, mounted above the cylinder, and a rotating mirror, *E*, which is in the form of an eight-sided prism and is carried at the rear of the motor box.

The front of the motor box consists of a curved pane of frosted glass, *F*, upon which the diagrams are projected. At the back of the box and outside of it is the light bulb, *A*, above mentioned. A beam of light passes through a small hole in the back of the motor box and falls on the concave mirror, *D*. From this mirror it is reflected back through the motor box to the eight-sided mirror, *E*, in the rear of the box, which may be either oscillated or revolved, according to whether pressure-volume or pressure-time cards are desired. The convergent ray of light is then reflected from the eight-sided mirror and projected forward upon the frosted curved glass, *F*, forming the front of the motor box.

The pressure-element consists of a small cylinder, *G*, and its piston. The lower end of the cylinder screws directly into the combustion chamber, the gases of



This huge stone crusher has a capacity of from 2,500 to 2,700 tons of stone an hour

which are free to pass into the cylinder. The pressure in the cylinder, *G*, raises its piston and compresses a resisting spring. This movement is transmitted through a vertical shaft to an arm which causes the curved mirror, *D*, which is mounted on the top of the cylinder, *G*, to rock on its horizontal axis and so change its vertical angle in proportion to the pressure on the piston. Thus, it can be seen that, as the pressure rises, so the reflected beam of light will rise upon the octagonal mirror at the back of the box and conversely, with the fall of the pressure, there will be a fall of the beam of light.

The eight-sided mirror, *E*, at the rear of the motor box is mounted on a vertical shaft, which is so geared that it rotates at exactly one-eighth engine speed. The movement of this mirror causes the beam of light to move to and fro across the curved glass front, *F*, of the motor box, which has been made ninety degrees in order that the beam of light focused and reflected

(Continued on page 688)

A Giant Among Stone Crushers

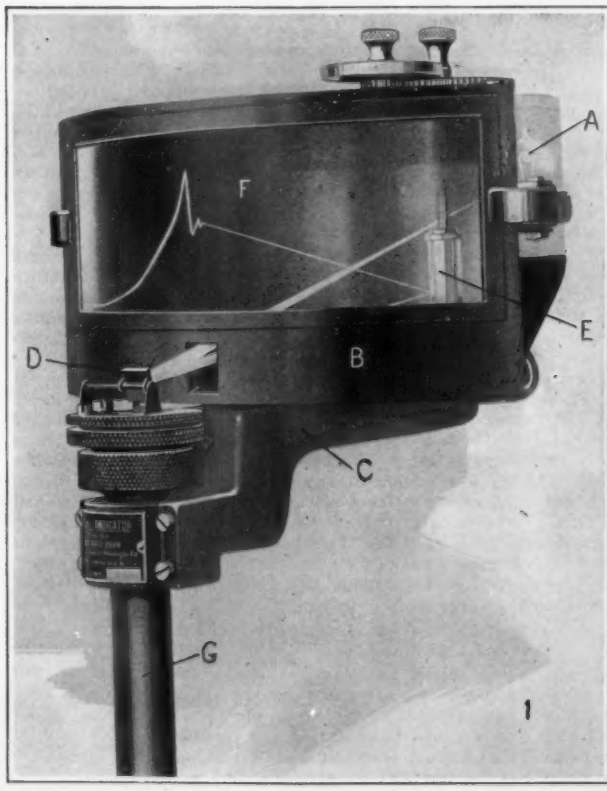
A HUGE stone crusher with a capacity of from 2,500 to 2,700 tons of stone per hour has recently been installed in a Michigan quarry. This stone crusher, which is said to be the largest in the world, has been the center of attraction for quarrymen ever since it assumed its finished lines in the Pennsylvania machine works.

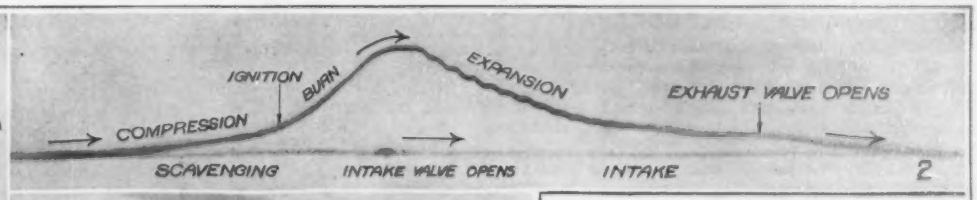
This large stone crusher, which is shown in the accompanying views, was built in ninety working days. Furthermore, despite its great weight and bulk, it was loaded on the cars, transported, unloaded and set up ready for work in fourteen days; a remarkable record, to be sure. The upper view, showing the revolving member which in conjunction with the stationary member does the crushing, weighs 65 tons.

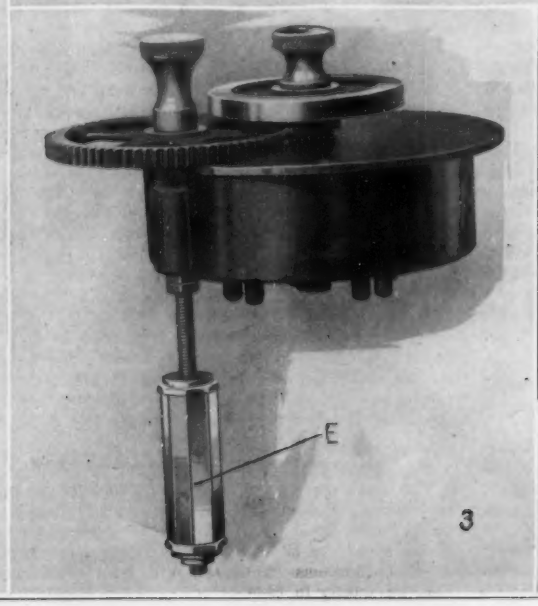
Measuring the Flow of Liquids

INSTRUMENTS for measuring and recording the flow of liquids have recently been brought out by a large British firm. In a description of these the curve deduced for the formula chosen to represent the flow of water over a weir or notch is cut on a drum in the form of a spiral or screw thread, the pitch of which increases from the zero end of the drum in correspondence with the increased rate of flow over the weir or notch as the depth of water increases. A float having a fine toothed rack attached to its spindle is placed the weir channel or in a chamber connected with it, and this rack engages with a union on the axle of the drum, so that the latter rotates as the float rises or falls. In cases where the depth of water exceeds about 12 inches a chain sprocket wheel is substituted for the rack and pinion. A pin attached to the end of a saddle arm engages with the screw thread and imparts a lateral motion to a slider bar carrying a pen, which is thus caused to move over a chart equal distances for equal increments in the rate of flow. The proportionate diagram obtained in this way can be readily interpreted by the aid of the planimeter and the total volume of water passed in any given time determined. The beak of the saddle arm as it moves along the graduated spiral groove gives a magnified indication of the rate of flow, and a pointer attached to the float rod shows on a scale the actual depth of water in the weir.

In another form of the instrument an integrating arrangement is added; this counts up the total number of gallons or cubic feet passed, and the quantity can be read off directly from ordinary counting dials. These recorders, for which an accuracy within one per cent is guaranteed, are applicable not only to determining the flow of rivers and streams, but also to measuring the feed water to boilers and the condensate from engines and turbines, as a check upon steam consumption and the efficiency of the plant.

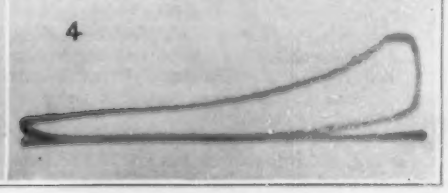






1. The optical system which provides a means for indicating either the pressure-volume or the pressure-time relations within the cylinder of an engine by making use of a beam of light. 2. Normal pressure-time card taken with the new indicator. The new indicator, by giving diagrams with pressure and time co-ordinates, has opened a new field for studying the behavior of fuels in internal combustion engines. 3. The synchronizer and rotating mirror—a detail of the mechanism shown in the first view of this group. 4. A conventional pressure-volume card.

Some features of a newly developed indicator for internal combustion engines and the results



Common Sense in the Laboratory

Some of the Ways in Which Better Executive Control Might Aid Electrical Research

By Professor Vladimir Karapetoff, Cornell University

FROM a condition where business men frowned on the suggestion that science might aid them in their business, the pendulum has swung to a point where the very name of research is sacred. In general terms this is doubtless good; but it has its drawbacks. There is too much tendency to look upon research as a miraculous cure for all evils—to think that we can take a man, set him up in a laboratory, and tell him to go ahead and research. As a matter of fact, there are a dozen ways in which the questions "Is this the man for this problem?" and "Is this the best attack upon this problem?" can be approached to the everlasting improvement of the current procedure in research. In the address printed here, and which he delivered in May before the Erie and the Cleveland sections of the American Institute of Electrical Engineers, Professor Karapetoff makes some very valuable and very concrete suggestions as to how we might better order the pioneering work which is being done in his own particular field.—THE EDITOR.

THE most natural division of unsolved problems would be according to the types of apparatus: for example, into problems in the design and operation of large turbo-alternators, improvements in lamps, circuit-breakers for larger currents and higher voltages, etc. Such problems may be multiplied ad infinitum, and I should not venture to express my personal opinion upon their relative importance. Hundreds of opinions have been expressed by competent men as to the specific needs for theoretical or experimental research in practically every branch of the electrical industry. I wish to offer another and somewhat unusual classification for the pending research problems which may be more helpful to those interested only in the broader aspects of research.

Where Caliber of Investigator Counts

One division of research problems that seems to me to be quite essential is based upon the caliber and mental equipment of the investigator himself. There are problems of great practical importance which can and will be solved by the expenditure of a sufficient amount of money and time. Thus, during the war the shortage of certain materials led to a large number of tests on substitutes, and in some cases satisfactory materials were found by men of average ability and education. A large number of such tests, sometimes dignified by the name of research, is being carried on all the time. For example, there are certain varieties of mica on the market or lubricating oils offered by the principal concerns, and comparatively simple tests permit to determine the kind best suited for a given purpose without employing men of unusually high caliber.

At the other end of the scale we have researches which require men of exceptional intellectual power and of wide erudition, researches which have baffled the most persistent efforts of many years and problems which remain unanswered in spite of the most alluring financial inducements. A reliable high-tension insulator and a simple variable-speed alternating-current motor may be mentioned as two such examples. Between these extremes there are innumerable gradations of mental caliber required for the solution of different kinds of research problems, and a clear realization of this fact is of utmost importance in the cultural development of the country. The tendency is to lay too much stress on material resources, equipment, and other external factors. A few men of superior caliber and thoroughly trained will accomplish results on which thousands of less gifted and not so thoroughly trained investigators may work for many years without much progress.

The necessity for better conservation of persons of exceptional scientific intellect is so urgent that it is legitimate to ask ourselves what our government, leaders of industry, educational institutions, or any other agencies are doing in this direction. The answer is, next to nothing. Moreover, in this imperfect world of ours it is no one's particular business to attend to the proper development of geniuses.

I do not have in mind a somewhat utopian scheme of breeding a race of intellectual giants by careful mating. I have in mind a perfectly feasible scheme of detecting exceptional children by suitable mental tests and then guiding them year after year to the full development of their mental powers. This is a proper function of the state and some day will become a reality.

Pure and Applied Research

Another classification of research problems is in accordance with their proximity to or remoteness from the direct industrial applications. A certain physical phenomenon, a mathematical formula, a peculiar alloy, etc., may up to a certain time possess no practical importance and be merely a subject of personal interest to a few investigators. Then one day someone discovers that that particular alloy or formula offers great practical possibilities and it becomes the subject of extensive industrial researches.

While such a state of affairs may seem perfectly natural and unavoidable, it has certain serious drawbacks for the best development of the art. The electrical industry owes many of its triumphs to so-called pure physical research, but until recently this industry offered mighty little encouragement to such research or to its exponents. Had the leaders of the electrical industry realized earlier the tremendous possibilities of physical research in improving commercial apparatus, then instead of sneering at "doctors" they would have used their talent long ago, and we would have been much further advanced in the applications of electricity than we are now.

But, it may be retorted, the scope of physics is infinite and how can an industrial concern keep on sinking hundreds of thousands of dollars year after year on the mere possibility that some of the results of physical research may at some time prove to be of use to it? The real situation is this: physical, chemical, or mathematical research involves first of all a method of approach, a method of attack upon a certain group of related problems, based on a thorough familiarity with the resources of that particular science. Promotion of research, therefore, consists primarily in the encouragement of the study and further development of such methods and not in the acquisition of a large number of unrelated facts. A scientist trained, say, in alternating currents will be prepared to approach a new problem in this field with much better chance of success than one who has had merely general practical experience and beats about the bush in an effort to discover a short cut by luck.

Thus the promotion of pure research is another national problem and the first aim must be the training in the methods of analysis, general laboratory methods, the ability to find what is already known, the use of mathematics, the use of methods borrowed from other branches of science, general accuracy of measurements, of computations, of statements, and last, though not least, that loving atitude toward nature and the intuition that comes only from a first-hand contact and observation of actual physical phenomena without any preconceived theory or utilitarian thought.

In the early development of our industry we sneered at all research. Then we called plain testing research. Later we grudgingly tolerated industrial research, that is, an investigation of a particular piece of apparatus in its complexity. Finally, it began to dawn upon some of us that an investigation of the very physical elements which enter into that particular piece of apparatus may lead to interesting discoveries. In this way it gradually became clear that a thorough investigation of the physical laws governing this or that branch of industry may be the quickest and the surest way toward remedying the difficulties in the operation and construction of certain pieces of apparatus. I should not be surprised if in a few years we should make a fad of pure research in industrial establishments and overdo it as we overdid safety and efficiency and patriotism and many other good things.

Experimental and Theoretical Research

The next division of research problems is into experimental, mathematical, inventive, critical, indicative of new fields, etc. A clear understanding of this division on the part of investigators themselves and of their business managers will help scientific progress materially in that it will allow each one to apply his effort, imagination, and inspiration where it will bear the best fruit and it will enable two or more investigators to combine their efforts without jealousy or duplication.

Almost any big research problem involves some theoretical study as well as experimental skill, inventive ability, and patient search for the work of other investigators and its critical analysis. Only a very few investigators possess all these accomplishments to the same degree, and it is in the hands of a harmoniously organized group of scientific workers of different talents that research leads to gratifying results.

A chain is strong only as its weakest link. Many a research worker has struggled in vain with a problem for which he was eminently fitted, just because he failed to recognize this one weak link in himself or was too proud to ask for help on some point of difficulty.

The Anglo-Saxon race is individualistically inclined perhaps to a greater degree than the other civilized races. The Americans among the Anglo-Saxons are especially prone to exhibit the western pioneer spirit in research with all its virtues and shortcomings of which the utter disregard of the work of preceding investigators is perhaps the most characteristic one.

Team Work in Research

I do not mean to imply for an instant that an original thinker should be hampered in the flight of his fancy by laboratory assistants or by skilled mediocrities, in the name of a misapplied principle of coöperation. I mean two other things. First, to clear a big idea in his mind, he ought to know how to let go of it and allow his assistants to play with it for a while and see how it shapes itself in detail. Secondly, if in the preliminary molding of his ideas he should be handicapped by his lack of mathematical ability or of foreign languages (two handicaps common in this country) let him not try to solve the problem in an imperfect manner alone without first having exhausted the possibilities of associating with other gifted and congenial minds who may furnish the missing needs of the problem.

An outsider and often a manager thinks that research men specialize by subject, so that one knows all about direct-current machines, another all about transformers, etc. While to some extent this is true yet there is a much more thorough-going and desirable specialization according to the nature of the man's talent. One is especially gifted in arranging ingenious methods for accurately measuring difficult quantities, whether it be in a-c or d-c machinery, another can skilfully present a phenomenon or a relationship in a mathematical form, a third is particularly adept in finding out quickly and accurately all the preceding contributions on the subject and in assigning the proper relative value or trustworthiness to each.

The possibilities of coöperation in research on the part of persons of different temperament and ability go far beyond the confines of one industrial organization or even one country. International coöperation in research is just as important in view of the favorable and unfavorable racial idiosyncrasies.

A student of the history of science can easily recall cases in which a scientific idea is born in one country and then is taken up by someone in another country and finally brought to a fruitful development in a third country. Perhaps the best known example in our line is that of Hertz, a German, who acted as an intermediary between Maxwell, an Englishman and Marconi, an Italian. A biologist could easily get examples of living organisms which have to live under different conditions at the various stages of their development. Thus the rust of wheat must live on barberry before it can live on wheat. We in this country with its polyglot population have had an exceptional opportunity to observe and to benefit by this coöperation right in our midst, even though in our Anglo-Saxon arrogance we are apt to look down upon our brothers from across the seas. There is hardly an organized institution for research in this country that cannot point to benefits derived from associates of foreign birth and training and point of view.

Relieving the Nitrate Pressure

The Development of Liquid Oxygen Explosives During the War

DURING the war the growing scarcity of glycerin and ammonia greatly increased the cost of dynamite. This caused the Bureau of Mines to investigate the possibilities of liquid oxygen explosives, which do not require nitrates, and an account of the progress made is given in the Bureau's Technical Paper No. 243, "Development of Liquid Oxygen Explosives During the War," by Geo. S. Rice, chief mining engineer. The paper describes the results of experiments conducted by the bureau at its explosives-testing station near Pittsburgh, Pa., and gives an account of the methods of use as developed in Germany, observation on its use by the Germans for destroying French iron and steel plants, and an abstract of a German military paper on instructions for using liquid air explosive.

The results of the Bureau's preliminary tests, begun in April, 1917, were decidedly favorable. Mr. Rice, while in Europe in 1919, as a member of a committee to observe progress in post-war industries, paid special attention to liquid-oxygen explosive. The Germans were found to have used the explosive, known as "oxyliquit," extensively in non-gaseous coal mines, in excavating subways and tunnels, in quarry, and in iron mines, as well as for destroying French steel plants.

The explosive was first tested at a coal mine in Germany, in 1897, following Linde's invention of his liquefying apparatus in 1895. Trials made in driving the Simplon Tunnel are said to have been favorable. In 1900, Claude, of France, patented the rectification principle. Linde, in 1902, designed his rectification apparatus. Both types of apparatus are extensively employed in liquefying gases. In 1904, Dewar, of Great Britain, invented the Dewar flask—a container for liquefied gases. Further development of liquid oxygen for blasting purposes was small until the war began. As already stated, its use was widely extended in Germany during the war.

The allied countries, being able to import nitrates from Chile, did not take up its use, but if the war had continued the United States would probably have been compelled to do so. The method will now have to depend on its merits and on commercial conditions.

The experiments of the Bureau of Mines have shown that a liquid oxygen explosive can be prepared which has a blasting strength greater than "40 per cent" straight nitroglycerin dynamite. This was shown by tests in the standard testing apparatus of the Bureau, as well as in blasting.

The procedure adopted was to place a No. 6 detonator in the inner cartridge, a cheese-cloth sack containing carbonaceous material. The cartridge is soaked in liquid oxygen 10 to 15 minutes in an improved container devised by the Bureau. The cartridge, frozen stiff, is slipped into a pasteboard container, placed in the hole, a wad of cotton placed on it, a brass tube inserted, and clay tamped around tube. The hole left by the tube provides an outlet for evaporating oxygen, until the shot is fired.

The advantages, as compared with dynamite and black blasting powder, are lower cost per ton of material blasted, elimination of dangers in transportation, from premature ignition, misfires, or unexploded sticks in ore or coal, in handling and thawing, or in storage magazines.

The disadvantages are: the liquid oxygen, because of its rapid evaporation must be used quickly after charging, thus limiting the number of shots. A liquefying plant must be maintained near the mine. The explosive cannot be used in gaseous coal mines.

Its introduction into mines is difficult, because miners are not accustomed to it. The method offers great possibilities for lessening blasting costs in nongaseous coal mines, and in metal and mineral mines using a chamber method where only a few shots are fired at one time. The chief cost is that of the oxygen, but there is hope of a decided reduction in cost through promised improvement in liquefying machines.

How German Potash Is Mined

POTASH in Germany occurs in the form of a rock salt and runs in seams of 30 feet or more in thickness. As mined, it has about the same consistency as the common rock salt of commerce, and its grinding is easy. It is ground to about the fineness of a coarse sand; in this form it is used for domestic agriculture, and at the present time it is also mostly exported in this form.

The depths at which the true potash deposits are situated render it necessary to sink shafts leading to levels of as much as 5,000 feet below the surface. Horizontal cuttings extend up to two miles in length. Owing to the very soluble nature of these salts, and to insure that the impervious covering remains intact, it is necessary so to construct the shafts as to prevent the inflow of water. This is done by means of brickwork lining, or where quicksands are present by a special system involving preliminary freezing.

The miners themselves are, unlike coal miners, entirely free from the danger of fire damp. Occasionally dangers arise from hydrogen, the blue flames of which may sometimes be seen flickering on the walls after a blasting operation in a newly opened mine. Sulfuretted hydrogen has caused the death of a few miners, and carbonic-acid gas renders suffocation possible. Every mine now is provided with a reserve ventilation shaft. A much more real danger is a sudden inflow of water, and one, too, which cannot be neglected. As a matter of fact, several of the more valuable mines have been wholly destroyed through such irruptions. As it was impossible to pump out the water owing to the soluble nature of the salts, these flooded mines had to be abandoned with the loss of all invested capital.

Another danger lies in the pressure of the upper strata. The roof has consequently to be substantially supported. In one mine alone (Ludwig II) 18 men were killed through a collapse of the roof. The former practice was to support the roofs by pillars of the salts left standing at regular distances, but these were found to crumble away too quickly. The system now adopted is to fill the cavities completely by stowing away waste materials and rock salt from the anhydrite region. Rock salt can be taken from the older deposits, and this salt being less easily corroded than the potash salt, columns of rock salt suffice to support the roof.

In the actual operations of mining and drilling, blasting is resorted to in order to detach the crude salts from the parent rock. Both hand and electrically-driven boring drills are used, and electric haulage is employed.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Pressure and Weather

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of the 22nd, you have a communication "Bad Weather and Good," which speaks of atmospheric pressure. The writer quoting another writer criticises his remarks as to effect of low and high barometers. Now, "All signs fail in a dry time," and I have found that saying correct in my sixty years as a Coöperative Weather Observer for the Government. For instance—yesterday and today wind has been northeast; weather raining and fog; humidity averaging above 90; barometer 30.26 which is 25 points above normal, hence, would be classed "high"; yet the smoke has persistently tumbled to the ground, and, in my experience it has often done so, say, 30 per cent of the time. I find many idiosyncrasies in the barometer both as to daily movement and to effect on results of atmospheric pressure.

CLINTON V. S. REMINGTON.

Fall River, Mass.

Why Ouija Works

To the Editor of the SCIENTIFIC AMERICAN:

I will endeavor to be as brief as possible in trying to answer a question of one of your readers, viz.: "An Appeal to Reason," by not giving the same old reason, "It ain't so."

Man is dual, conscious and sub-conscious. Do you want proof of this? A man under hypnosis given the suggestion that he is Aristotle, will instantly assume that character, or any other that he may be familiar with in his conscious condition.

Strange enough he will act out the part as well as the best actor. The sub-conscious mind believes any suggestion it receives.

Belief is the necessary thing in all psychic manifestations, Ouija or otherwise, whether it be Sir Oliver Lodge or a savage, Jesus of Nazareth or Peter about to walk on the water.

Faith is not confined to great learning. If you will perform the following experiment in good faith, never doubting it for an instant, you will have the basis of Ouija or any like experiment:

Sit opposite another party. Lightly hold one of his hands. Place a number of small articles before you, three or four, or playing cards. Close your eyes. Have your partner rearrange the articles while your eyes are closed at the same time making your mind blank. Have him say which article he wishes you to pick up, then you act slowly and deliberately. You will be able to do so according to the degree of your faith.

The Ouija, in my mind, ninety times out of a hundred can be attributed to your sub-conscious mind, or the action of the minds of the participants collectively. They unknowingly have hood-winked themselves. The scrap lumber hasn't anything to do with the experiment.

Let me give you another experiment: Attend a spiritualist meeting and give the medium the smallest bit of information about an erroneous person and watch the amount of plausible data he will give. It is simply a case of self-hypnosis acting upon a suggestion.

For instance, tell the medium if you happen never to have had a sister, "I would like to receive a message from my dead sister," and watch the deduction of the sub-conscious mind. You will probably get a very plausible description of her, imbibing some of the most prominent characteristics of your own self. I have been an impartial observer of psychic phenomena for a good many years and these are my conclusions:

Psychic phenomena are a manifestation of the sub-conscious mind. Whether or not it is acted upon by life after death, I am not willing to say. I don't know. I do not propose to be a gate-keeper of human knowledge and events, and can only state the facts as far as I have been able to perceive them.

Another experiment proving that the hands do propel the Ouija and Ouija does not guide the hands: Make two heart-shaped boards similar to the conventional Ouija and place three ball-bearings between these two boards with an indenture for each ball bearing. If any impulse be given the board it will simply slide off.

R. H. POWELL.

Oakland, Cal.

The Life Gun on the Ship

To the Editor of the SCIENTIFIC AMERICAN:

Answer to Mr. George H. Tripps' letter published in your issue of March 20th.

I thoroughly agree with his principle which is entirely correct, but I would also state that in twenty years' sea experience I have never gone to sea in a sea-going vessel that was not equipped with the means of throwing a line from a shipwrecked vessel to the shore.

In fact it is an iron bound United States law, reading as follows: "All ocean steam pleasure vessels and ocean steam vessels carrying passengers, except vessels of 150 tons or under, shall be provided with at least three line-carrying projectiles and the means of propelling them, such as may have received the formal approval of the board of supervising inspectors."

The type of gun used is similar to the one illustrated on your cover of January 31st, 1919.

We carry three light lines coiled in a box, 1,700 feet in length and capable of withstanding a breaking strain of 500 pounds. One of these lines is made fast to the projectile which weighs 18 pounds. The projectile is placed in the gun and fired ashore, carrying the line with it, that in turn is picked up the coast guard, who make a block with a heavy rope rove through this block fast to the ship's line. On a given signal this endless line and block are hauled out to the ship and lashed at the highest place preferably up a mast. Then the coast guard haul out the breeches buoy and take off the passengers and crew.

The gun, lines, projectiles, powder, primers and instructions for using same are kept in a water-tight box on the uppermost deck where it is always accessable.

This gun is inspected and tested out once every year by the United States Inspector of Steam Vessels.

The signals used between the ship and coast guard are by colored lights. To attract attention, rockets are fired by night, gun fire by day.

Captain, Steamship S. B. Hunt. EDW. G. BANCORD.

What is Wrong with Our Paper Supply?

Some Reasons Why This Essential Material Is Scarce and High-Priced

By H. A. Mount

THE average man has not concerned himself much about the paper shortage for the good reason that, to him, there doesn't seem to be any. Newspapers and magazines generally are larger than ever. It is true that a few small newspapers have been forced to suspend publication, but these have been isolated instances. The newspapers and magazines which have told of a paper shortage, by their very size seem to belie their statements. There has been a Congressional investigation, but Congress investigates everything, and that, too, has been rather unconvincing. About the only real evidence, to the average man, is the increase in price of his morning paper. But everything else has raised and so there has been little significance in that. On the whole, we cannot blame the man of the street if he is a little skeptical about the "paper shortage."

But, undoubtedly, there exists in our paper industry today a very real crisis, and unless some agency intervenes, that crisis very soon will become an equally real famine. And here is one condition that can't be blamed on the war. It has been growing on us for years and a sudden increase in the demand for news and magazine papers has forced upon us the realization of the real situation. In spite of the fact that newspapers and magazines are using more paper than ever before, nearly every one of them is limited in size by the amount of paper it can buy. Many magazines would be twice their present size if they could secure the necessary paper.

Several of the large newspapers bought outright or secured a controlling interest in big paper mills to insure for themselves an adequate supply of paper. But they secure their supply at the disadvantage of smaller publications, which must buy their paper in the open market.

The crux of the whole situation is a shortage of raw material. And "raw material" in this case means spruce timber. More than 90 per cent of the actual ingredients of paper—all kinds of paper—is spruce timber. Rags are added in making some of the finer grades of writing paper, but the tonnage of rags used is comparatively small. Old newspapers and magazines are used over again in the making of cardboards and wrapping paper, but the amount salvaged in this way also is but a "drop in the bucket." The United States uses over 38,000,000 tons of paper in a year and to produce this about 57,000,000 tons of spruce timber are required. To obtain this enormous tonnage we have in the past cut down our spruce forests at a terrific rate. We have made no effort to replace the trees as they were cut down, and it took 150 years to grow each one of those forest giants. So we now find ourselves in the embarrassing situation of having to depend on other countries for two-thirds of our paper pulp.

It is a staggering fact that the average issue of a New York morning paper devastates from 25 to 90 acres of forest. Most of our paper mills were built in the New England States or in our Lake region to be near "unlimited" supplies of raw material. But today, practically every mill is hauling its lumber from a hundred to a thousand miles by boat or rail.

This fact has practically halted building operations in the industry in this country and, while some of the mills have enlarged to meet a growing demand, there have been practically no new news or magazine paper mills built since 1915. The Canadian paper industry, on the other hand, has grown since 1915 by leaps and bounds and now supplies much of our paper.

The United States still has two great reservoirs of raw material untouched. These are the spruce forests of our northwest and those of Alaska. These have remained untouched because of the long haul necessary to reach the consumers of paper, most of whom are in the East. But even these unused resources will not solve the paper problem for any long time. One large publisher, before a Congressional committee, estimated that at the present rate of increase in paper consumption we will have exhausted half our supply of pulp wood in 15 years.

Very evidently we cannot go blindly on, as we have been in the past. But what's to be done?

There is always the possibility of placing Governmental restrictions on the use of paper. Voluntary reduction of the size of publications seems impossible because no one publisher is willing to take the step while his competitors are getting out large papers or magazines. And yet it is the opinion of many publishers that the public could be adequately served, and at a profit, by smaller publications.

All authorities are agreed that we should lose no time in reforesting the devastated areas. But even supposing the annual growth of timber can be made to equal the cuttings, relief from this source lies in the future.

IF paper is high and scarce because there are not enough mills making it, why not build more mills? If the reason is a scarcity of spruce pulp, why not use some other wood? If there is any reason why this can't be done, why not use some other substance altogether? If the forests that have supplied our paper in past years are about worked out, why not move the industry to a fresh field? The answers to all these questions and many others must be stated very clearly before the layman will realize why the paper situation is so acute and apparently so incurable. Mr. Mount answers them in this article, and shows from just what directions, and after just what lapse of time, relief may reasonably be expected.—THE EDITOR.

And then there is the possibility that someone may finally discover a substitute for spruce timber. To understand efforts along this line we must know something of the process for making paper and just why it is that no other raw material than spruce can be used successfully.

In making newspaper, two kinds of pulp are used, "ground wood" and "sulfite pulp." In making the ground wood, spruce logs are shuttled back and forth across the face of a huge grindstone, with a roughened face. Water flows over the stone at the same time and the wood is ground into a very fine pulp.

The making of sulphite pulp is more complicated. By a chemical process sulfur and limestone are combined to produce sulfuric acid. A solution of acid and water is placed in a huge "digester"—a big steel tank with a lining to protect it against the acid action, and built to withstand enormous internal pressures. The spruce wood is cut up into coarse chips and the digester is filled with these chips.

The mixture of chips and acid is cooked under pressure for from six to eight hours and is constantly agitated by live steam during this period. When the cooking is finished the result is a mass of brownish wood fibers. These fibers are then bleached by the use of more chemicals.

The wood fibers produced by the sulfite process are longer and tougher than those produced by grinding the wood. Sulfite pulp is more expensive than the ground wood, however, and just as little of it is used in paper making as possible.

In the production of news print paper about 80 per cent of ground wood is used and 20 per cent of sulfite pulp. The pulp is placed in vats at one end of a huge machine and comes out the other end as paper ready for the press.

The pulp is first mixed with water and strained so that the liquid is of an even consistency. It then flows under a dam board to a revolving screen of very fine mesh. The screen permits the water to drain off but retains the pulp. The pulp is carried along for a distance of 30 feet or more on the screen while the water drains off, and then the layer of pulp is peeled off and fed between two rolls, which squeeze out more of the water and compress the pulp into a sheet of paper.

Right here is the real "neck of the bottle" of the whole situation. No other material than spruce pulp has been found which will cling together sufficiently at the end of the screen to allow it to be peeled off and fed into the rolls at high speed. The ground wood alone will not do it and the sulfite pulp is added for the very purpose of holding the pulp in a sheet at this point. The fiber, to accomplish this properly, must be neither too short nor too long.

Once the sheet has been fed into the first set of rollers the process is a simple one. The paper passes through other sets of rollers which further compress and dry it, and then passes over other steam-heated rollers, which complete the drying. At the end of the machine, it is delivered to a big roll as a continuous sheet of paper with a width as great as 13 feet, and at speeds as high as 900 feet per minute. In the final process it is rewound to another roll, passing knives which trim the edges and cut the sheets to proper width for the newspaper presses.

If a glossy finish is desired, the paper passes through a "calendering machine" at the end of the paper machine, before it is delivered to the roll. In the production of magazine papers and coated book papers, the ground wood pulp as well as the sulfite pulp is bleached before going to the machine and more sizing, composing chiefly of resin, added to the pulp.

The production of all kinds of paper follows these general lines, although the technique varies greatly with the kind of paper. In the production of cardboard and wrapping papers, old newspapers and magazines are ground up and used as pulp, but the amount of material salvaged in this way is not great.

It is a rather surpising fact that the amount of paper pulp used for wrapping papers and cardboard for paper containers exceeds slightly the amount used in the production of newspapers. Only one-fourth as much pulp is used for book papers, such as this magazine is printed on, as for newspaper. Writing papers and all others combined used less than half the amount of pulp required for newspapers.

While theoretically the limiting factor in the speed with which paper is produced is the tenacity of the wood fibers at the point where the sheet enters the rolls, practically the speed of the paper machine is often limited by the mechanical difficulties encountered in driving it.

Due to the fact that the paper shrinks as it dries the rolls near the delivery end of the machine have to be run at a slower speed than those at the other end. There must also be some flexibility in

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The paper itself weighs nearly two pounds. The raw materials for this paper as seen from left to right are 1 ounce of bleaching powder, 2 pounds of coal, 3 pounds of spruce wood, 1 ounce of sulphur, 1½ ounces unslacked lime, and a small quantity of red and blue dye. The entire edition of such a paper consumes the wood from about 100 acres of forest.

A metropolitan Sunday news sheet, and the materials that go into it

With Our Latin Customers

Engineering Works That Have Put Venezuela Abreast of the Twentieth Century

By Harry Chapin Plummer

STEEL girders from Youngstown, Ohio; spiral riveted pipe from Newburgh, N. Y.; screens and iron beds from Indiana; hospital plumbing and sanitary equipment from Pennsylvania—such are some of the major items that are being requisitioned from the United States at present by both the National Government of Venezuela and the Federal District Government of Caracas in the prosecution of an ambitious sanitation and public improvements program.

Of the world's nations, Venezuela was the only one saving the United States that, during the four years of conflict, regularly and punctually amortized her debts contracted abroad, although by an agreement entered into with the foreign bondholders in London, when the war broke out, she was privileged to defer her interest payments as they fell due, if conditions and circumstances warranted. This extraordinary fiscal position to be attained by a nation of such limited population—less than three million—and in a time of such social, political and economic upheaval, has had the effect of placing the Venezuelan unit of currency, the bolivar (ordinarily equivalent to 19.3 cents in American gold) upon an enviably sound basis, whereupon it has reacted to astonishing premiums over its normal parallel in the standard currencies of Europe. This has operated, naturally, to render Venezuelan credit exceptionally stable and to make it a desirable objective of the financial and commercial parts of the world. Under this plethora of fortune, public improvements in Venezuela which one might say were little more than yearned for in 1914 have come to be realized in tangible and definite form in 1920.

White enameled beds and screening brought from the United States and now used in the Venezuelan hospital

Before the war Caracas enjoyed none too enviable a reputation for cleanliness, sanitation and health. The city's streets and approaches were ill-paved, or not at all paved, and sewerage facilities existed in the minimum, where, for reasons obvious to any one who is familiar with the locality (within less than ten degrees of the Equator) these should have existed in the maximum. Too, there were lacking reception and isolation hospitals for the observation and treatment of contagious diseases. No better illustration of the shortcomings of Caracas from a public health viewpoint, as late, even, as at the close of the war, could be afforded than the frightful toll which was exacted from among its population of close upon 100,000 by the visitation of the "flu" epidemic early last year. The lesson thus taught, however, provided the "blessing in disguise" that brought about the "clean-up" and reform of the city's streets and sewerage system, the amplification of the water supply and the building and equipment of a modern isolation hospital.

One phase of these improvements, that of the repaving and modernization of the streets of Caracas for automobile traffic, bears a close relation to and dovetails with a national governmental policy of motor-highway construction by which, as told in the SCIENTIFIC AMERICAN recently, 1,800 miles of magnificently equipped roads already have been opened for public use. These, having Caracas as their focal center, extend in all directions and serve to connect not only the capital but the principal seaports, La Guaira, Puerto Cabello, Ocumare de la Costa and Maracaibo, with interior points as far distant as the Andean cities of Merida, Trujillo, Tachira and San Cristobal, the latter on the Colombian boundary; Ciudad Bolivar, San Fernando del Apure and other communities of the great Orinoco basin; and still other cities and regions of southeastern Venezuela toward the Guiana and Brazilian frontiers.

Directly attributable to the improvement of the thoroughfares of Caracas and the building of the great trunk-line and lateral highways of the interior, is the present ownership by the *Caraqueños*, as the residents of the capital city are styled, of one thousand motor cars, a ratio of one car to every one hundred inhabitants. This is a condition that, like the public improvements cited, has developed since the assassination at Sarajevo. The realization of the perfected urban streets and rural roads, which maintain their continuity of excellence through interior cities and *pueblos* alike, has had the natural effect of placing such important industrial centers of the republic as Maracay, Valencia, Barquisimeto, Puerto Cabello, La Guaira and Barcelona within easy access of the capital, whereas, heretofore, each represented a long and tedious railway journey or a longer and yet more tedious ride on horseback.

When a survey of water supply and sewerage conditions was begun by the Ministry of Public Works of Venezuela as a step preliminary to the planning of the two great works now approaching completion, the startling discovery was made that in one of the most thickly populated districts of Caracas a sewer-line passed over a water-main and the former, having become worn and deteriorated, its contents had found an actual point of contact with the flow in the water-pipes entering nearby dwellings. The gravity of this situation was at once realized and both the sewer and the water-main and its ramifications were straightway condemned and the new systems carried into execution.

When they came to consider the diverse systems that are employed today for the draining of large communities, the Ministry experts arrived at the conclusion that the most convenient and practicable one, taking into account the customs and habits of the population and the topographical conditions and environment of the city, would be the unitary system, which receives conjointly the residual waters and those of the rains. This is a principle applied in Venezuela up to this stage solely in house interiors, leaving the rain waters that collect in the avenues and streets to seek the courses they would naturally follow by gravity and depending upon the sewers only in exceptional cases where the topography of a given place renders their use indispensable. This plan, which is a modification of the current unitary system, offers specific advantages, from the economic point of view. The narrow streets of Caracas sustain, during the rains, vast volumes of water that gravitate from the northern part of the city and which re-

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1. Steel girders imported from the United States for construction work on half-million dollar acqueduct. 2. Steel girders from the United States resting on reinforced supports of native concrete. 3. Newly-built isolation hospital at Ricon del Valle, near Caracas, equipped and outfitted, except for native cement, with American materials.

How Venezuela is making use of American materials in the construction of her public works

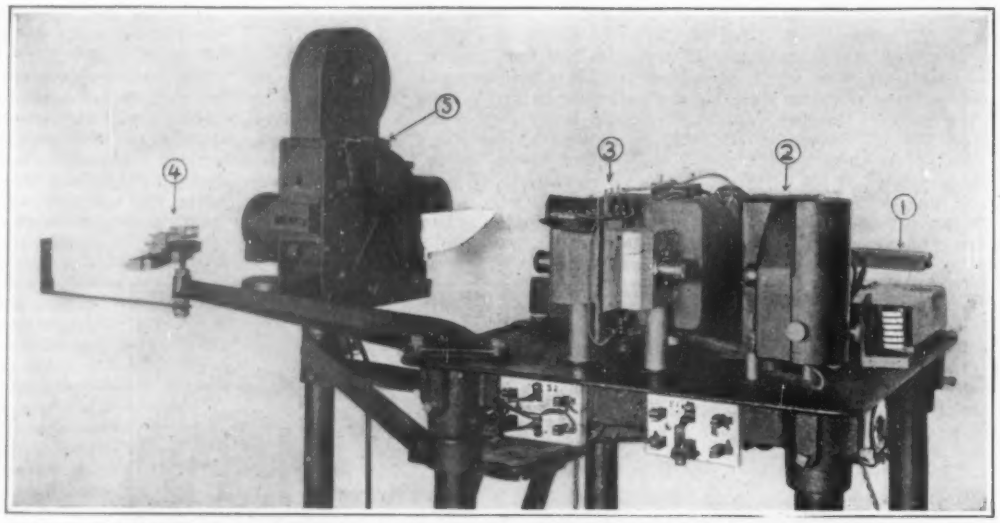
When the Heart Tells Its Story

How Electrical Engineers Have Developed a Practical Cardiac Recorder for the Medical Fraternity

By M. A. Henry

THE surgeon of the very near future may have before his eyes during an operation a "motion picture" of the vitality of his patient. Or, if he prefers, he may wear a "head set" telephone receiver by means of which he can listen to every muscular action and reaction from heart beats to minute muscular tremors as he works.

Application of the vacuum tube amplifier to the Einthoven string galvanometer makes this medical achievement an imminent possibility. The application in question has produced a very much more robust, and at the same time, more sensitive and accurate instrument, which at least promises to supersede the common form of string galvanometer, long used in medical science in the taking of "electric cardiograms" of heart action.



1. Tuning fork for controling synchronous motor for timing. 2. Casing which encloses light, synchronous motor and timing disk. 3. The galvanometer. The magnet coils can be seen in the back, and the perpendicular frame between the lenses, which holds the string. 4. The prisms which reflect the light from the galvanometer to the recording box. 5. The recording box. It contains a roll of sensitized paper and chemical baths for developing it. The finished record is delivered in the rear. The motor for operating the recording apparatus can be seen attached to the far side of the box.

Complete equipment for making photographic records of heart beats as shown in the group below

The old form of the instrument is a very delicate apparatus and requires a highly trained technician to operate it. It might have been applied to the operating room had it not been for the fact that it could not be successfully operated by a person ordinarily familiar with delicate instruments, and the fact that there is no time for "fussing around" with adjustments during an operation. Both of these objections seem to have been met in the new instrument, and medical authorities agree that it may prove of the highest value to the surgeon.

The ordinary Einthoven string galvanometer consists of a powerful electromagnet, the poles of which are brought very close together, setting up a magnetic field of great intensity. Between the ends of the poles a very fine "string," usually a quartz fiber with a metallic plating, is stretched. The instrument depends for its action upon the fact that the human body is, in a sense, a weak electric dynamo. Every muscular action generates electric current, and if these currents are conducted to the ends of the galvanometer "string," its reactions in the magnetic field cause the "string" to vibrate from side to side. These vibrations of the string are recorded by throwing the shadow of the moving string upon a moving strip of sensitized film or paper.

When the body is in repose the principle electric currents are from the action of the heart and the "curve" obtained from the galvanometer under such conditions has been found a very accurate gage of the heart action. It will be seen, however, that the body currents are very slight, averaging about one milli-volt, or a thousandth of a volt, and that, therefore, the "string" of the galvanometer must be extremely delicate in order to respond to this feeble current. The current fluctuations due to heart actions are very slow and in order to be sensitive to this low frequency rate, the "string" need not be held taut under high tension, but relatively slack as its delicacy requires. This makes it insensitive to high frequencies. On account of the delicacy of the "string" and the fine adjustment necessary, the operation of the galvanometer has been an art within itself.

By the simple expedient of amplifying the weak body currents through a series of vacuum tube amplifiers, before they reach the galvanometer, these difficulties have been overcome. In the instrument, in its present development, four amplifiers are used and these bring the body current of one-tenth microampere to about fifteen milliamperes, an amplification of 150,000 times. The actual energy amplification is, however, only about 100,000 times, due to the difference in the resistance of the body and the galvanometer string.

The stronger current in the instrument permits the use of a very much more robust "string." The "string" can also be stretched tighter and is sensitive to vibration rates of from zero to many hundred cycles a second. It may furthermore be better dampened so as to have uniform sensitivity over a wide frequency range.

The instrument has also been improved mechanically so that the complete permanent record can be had within a minute after making a test. The shadow of the vibrating string, cast by an electric lamp, falls on a small prism and is deflected to a dark box containing a strip of highly sensitized photographic paper. The paper is carried on a reel and is moved past an opening at a fixed rate of speed by a small motor. Time signals are made on the paper in tenths and hundredths of seconds by cutting off the light periodically by the use of a rotating shutter between the lamp and the prism. The shutter is operated by a small synchronous motor, controlled by an electrically-operated tuing fork of constant amplitude.

A convenient method of taking the current from the body is to dip the hands in a salt solution and to touch two brass electrodes, from which the current is conducted to the amplifiers. The salt solution makes a better electric contact between the hand and the electrodes.

The only explanation so far advanced for the tiny high-frequency vibrations recorded by the machine is that they are due to muscular twitches, perhaps due to grasping the electrodes, possibly also due to some nervous phenomena. In support of this theory it will be noticed that these high-frequency vibrations are much more pronounced in the record obtained from the nervous man than from the muscular, robust individual (Figs. 1 and 2).

In the record made of a girl before and after running upstairs, it will be noticed that although the heart record is much faster in one curve, the secondary high-frequency vibrations are about the same in each case (Figs. 3 and 4).

The instrument is, of course, sensitive to any muscular action. If one of the large muscles of the leg or arm is contracted during a test a very large deflection is noted. This is illustrated

(*Continued on page 692*)

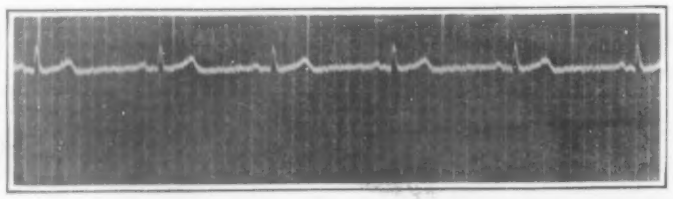


Fig. 1. This record shows the high-frequency current generated by the heart of a normal man. Note the evenness of the high-frequency waves.

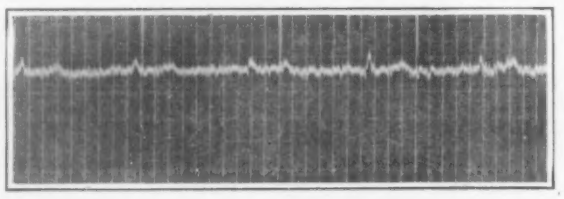


Fig. 2. Record of the heart action of a nervous man, showing the pronounced high-frequency waves. Compare this record with the foregoing one.

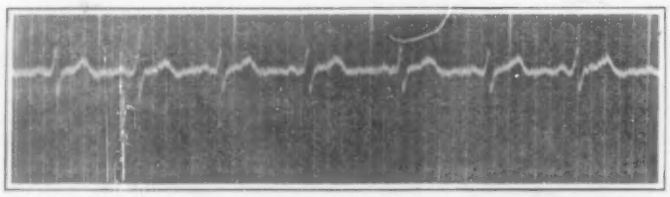


Fig. 3. This record shows the heart action of a girl before she ran upstairs. Note the relative evenness of the waves as compared with the next record.

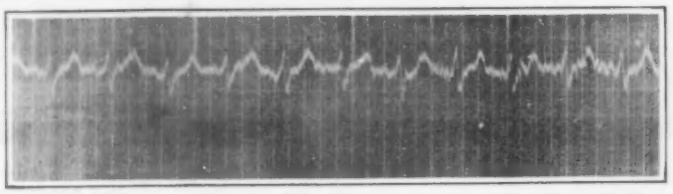
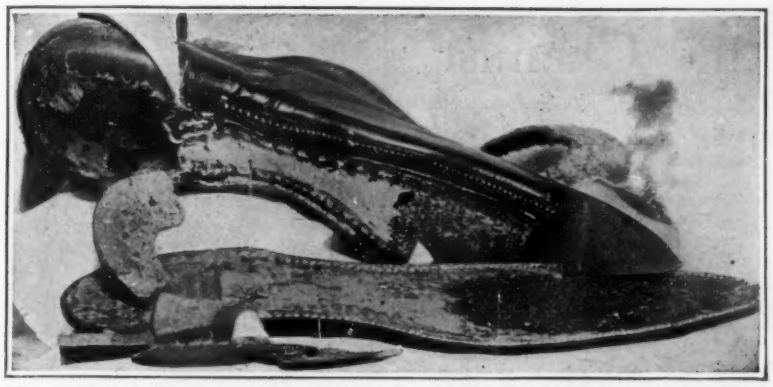
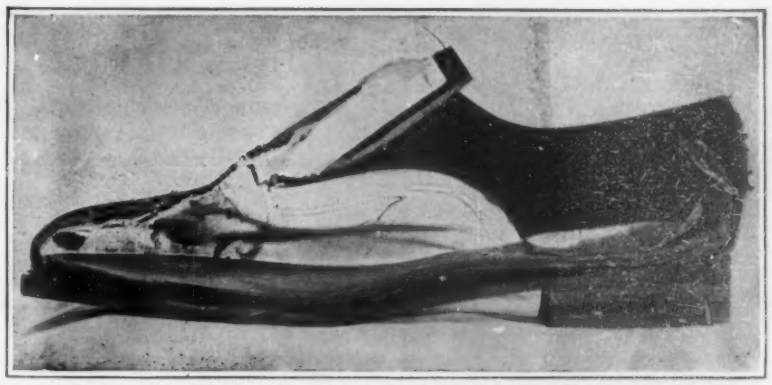


Fig. 4. Record of the heart action of the same girl after she ran upstairs, showing how the muscular effort has placed an additional strain on the heart action.



The part-paper shoe torn apart reveals a very thin innersole with canvas back, fiber box toe and counter, paper in undersole and half-paper heel



All leather shoe split in half. Note heavy leather for innersole. Steel spring supports the instep; cork filling between inner and outer soles

How Much Paper in Your Shoes?

By Ralph Howard

IT'S rather hard to believe that half of us are wearing shoes made of part paper, but such is the fact. Authorities agree that fully half of the shoes being manufactured contain a percentage of paper.

This is not only true of the cheap shoes but of so-called "high-grade" lines, selling from $10 a pair upwards. The use of paper reduces the wearing qualities of the shoes, but it is probable that all-leather shoes made at the same cost would not wear as well. The saving effected by using paper permits the use of better leather in the parts most exposed to wear.

Pressed paper is often used for the upper layers of the heel, and shellacked fiber is used for box toes and "counters." Another method of saving is to split the leather inner sole into two, and line them with heavy canvas. Thus two inner soles are made from the leather ordinarily used for one, at only a slight increase in price over one piece.

A shoe so constructed is likely not to "hold its shape" well, especially in wet weather, although, if a good quality of leather is used in the sole and uppers, it may give good wear. Makers of all-leather shoes maintain, however, that it is good economy to pay a couple of dollars more for shoes in which no paper is used.

These two shoes sell for same price and look identical in workmanship and material. Yet one is all leather and the other part paper

The substitution of paper for leather is so well done, however, that it is impossible to tell from ordinary observation whether paper is used in the shoe or not. Even experienced shoe buyers find it difficult to tell and usually rely on the statement of the manufacturer.

One shoe buyer for a chain of large stores has originated the practise of tearing up one shoe of each case lot he buys to see just what material is used. If he finds any paper in the sample selected at random, the whole shipment is returned. These stores pride themselves on the fact that they sell "all-leather" shoes.

A simple test is usually effective in determining whether or not a shoe is all leather. If paper is used, it is usually in the upper sections of the heel. If the point of a pocket knife is pressed on this part of the shoe, with the width of the blade parallel with the layers, it will readily sink in if the heel is of paper, but leather will resist quite heavy pressure from the knife.

If paper is found here, it is good evidence that it has been used elsewhere in the shoe. Another test is to bend the counter inward. If it is of leather, it will at once spring back into shape, but if paper or fiber is used the counter will remain bent. A similar test can be applied to the toe of the shoe. If the box is pressed in, it is so resilient that it will spring back if of leather, but will remain permanently dented if made of paper.

Electric Power from Sunlight

By Paul Kirkpatrick

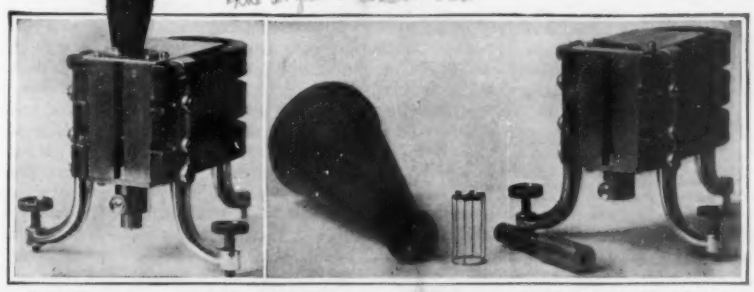
THE task of more directly getting hold of the radiant energy of the sun for the purposes of mechanical motion instead of pursuing it around through the indirect and labor-involving processes of organic growth, evaporation, combustion, or other of its secondary terrestrial effects, is both important and fascinating. The problem has always been a leading one in the interests of experimenters and it is clear that a complete solution would have profound effects upon human life.

The instrument shown in the accompanying illustrations is one which develops its small amount of power immediately upon exposure to sunlight. It is a form of electric motor yet is independent of batteries or any external current source, its minute currents being thermo-electric, resulting from the heating radiation which falls upon it. The currents arise within the armature and do not leave it.

"Of the motor's separate parts, the drum armature, resembling a cage, is made up of vertical wires of silver joined at the upper ends to short spokes of German silver. The junctures, the seat of the electromotive forces, are flattened to present a greater area to the rays impinging upon them, and are blackened to facilitate quick temperature changes. Models with two, four and six armature members have been found successful but those with the larger number possess a smoothness of action similar to that gained by the use of many cylinders in a gasoline engine."

In operation the armature is carried by one bearing, a jewel, in the pole gap of the large permanent magnets. An iron core is also placed in this gap, strengthening the magnetic field and providing a support for the jewel. The conical metal reflector may be used to concentrate the radiations, which strike into the pole gap vertically.

A screen is disposed here in such a way that at all times three of the six thermo-couples are reached by the rays. These become warm relatively to the three which are shaded. Currents result which, traversing the armature wires, react upon the magnetic field and cause rotation as in any electric motor. As rotation proceeds each couple at a certain point crosses the boundary of shade and changes from hot to cold or *vice versa* and so the currents preserve their proper directions at all times, the device of the screen serving for the brushes of an ordinary direct current motor.



Left: The motor assembled. *Right:* The parts—cone for concentrating the incident heat, armature, iron core, and magnets in stand.

Motor that operates through the electromotive force of hot and cold junctions of a thermocouple, giving minute power when merely exposed to the sun or a lamp

The motor will operate under the action of sunlight or an electric lamp or any other source of energetic radiation, visible or invisible. If the position of the shading screen is properly altered the direction of rotation is reversed. A particle of carbon dioxide snow of the size of a match head placed near the armature on the exposed side will also reverse the rotation. A convex lens of glass may be used to concentrate the radiations instead of the metal cone shown, but being opaque to long waves the glass absorbs much of the useful energy of the incident rays.

Fighting for Healthy Plants

By W. A. Murrill

THE science of plant pathology, or the investigation and control of diseases of plants, particularly those caused by fungi, has been pushed forward of late with greatest rapidity in the United States.

During the period of the war, our experts in this field from the different states coöperated very closely to save as much as possible of every crop from the ravages of disease; and during the summer of 1919 this idea of coöperation was continued and extended with great success. In the neighborhood of New York City, two important field meetings were held, one on Long Island and one at New Haven, Connecticut, for the study of diseases common in those localities.

The first meeting, in June, for the study of potato diseases in particular, was attended by about one hundred plant pathologists representing many parts of America, England and Holland. The farmers furnished motor-cars and tours were arranged for the chief potato-growing sections of Long Island. In the evenings, mosaic, leaf-roll, wart disease, and other potato troubles that have been found difficult to combat were discussed at length, with the best experts in the world on the spot to put their heads together and work out the best methods of control.

The second meeting was held in August and was attended chiefly by experts from New England and New York. Automobile tours covering a distance of three hundred miles were made to plantations, gardens, and nurseries between New Haven, Hartford, and Storrs; while every evening of the week was devoted to papers and discussions. The largest greenhouses in America were seen at Cromwell, where 22 acres are under glass, one house being 800 feet long and another 500 feet square, the latter entirely filled with roses. The largest elm in the United States, at Wethersfield, is 30 ft. in circumference, 97 ft. high, and 250 years old.

A day was spent in the tobacco-growing regions of Connecticut, where broad-leaved tobacco is grown in the open and narrow-leaved varieties are cultivated under tents. At one place were seen 290 acres under cloth.

The Service of the Chemist

A Department Devoted to Progress in the Field of Applied Chemistry

Conducted by H. E. HOWE, Chemical Engineer

Corrosion in Heating Systems

WHEREAS heretofore it has been the rule to empty and wash out steam and hot water systems at the conclusion of the winter, recent investigations indicate the advisability of only turning out the rust that settles, avoiding the addition of any more than the necessary amount of fresh water. In a recent paper by F. N. Speller and R. G. Knowland, it is stated that the factors which cause corrosion and determine the rate of corrosion are non-condensible gases rather than differences in various grades of good wrought iron and steel pipe. Pipes for hot water heating do not suffer seriously if the same water is kept in circulation and in systems where open heaters are included, where water comes to rest at 180°F. or higher, gases are discharged and the pipes show practically no corrosion after ten years' service. Storage tanks which permit practically all the free oxygen to escape, appear valuable and the pipes in such systems have shown no corrosion after three years of service. Since under such conditions free carbon dioxide is not removed, it is concluded that the effect of this gas on such a system is negligible. A steel sheet or expanded steel lathing in open heaters or storage tanks assists in the removal of non-condensible gases. The authors state further that where exhaust steam is used a coating of oil usually forms a protection upon the pipes and experiments with heavy oil added to the steam used in steam turbines have greatly reduced corrosion.

Food Sources

IN the Proceedings of the American Philosophical Society Dr. Raymond Pearl gives statistics with reference to the various sources of the chemical compounds which make up the essentials in our diet. More than 50 per cent of the protein is contained in animal foods other than fish; 36 per cent, including 28 per cent from wheat, comes from grains; 26 per cent from meats; 20 per cent from dairy products, and about 7 per cent from poultry and eggs. Of the fat eaten, 51 per cent is derived from meats including 40 per cent derived from pork and its products, 27 per cent from dairy products, 12 per cent from oils and nuts. Our carbohydrates are principally from grains which supply 56 per cent, 26 per cent is from sugars and the remainder is to be found in fruits and vegetables and dairy products.

The energy usually expressed as calories is contributed as follows: 35 per cent from grains, 22 per cent from meats, 15 per cent from dairy products, 13 per cent from sugars, 5 per cent from vegetables, 2 per cent from fruits, 2 per cent from poultry, and 5 per cent from vegetable oils and nuts. In this connection statistics advise that the average daily food consumption by the adult man is 114 grams of protein, 127 grams of fat, and 433 grams of carbohydrates, totalling an average of 3,424 calories daily.

A By-Product for Enamels

SOME of our phosphate rocks carry an amount of fluorine sufficient to lead one chemical engineer to consider methods for its recovery and utilization. Following a series of experiments the technique of recovering this fluorine from the acid phosphate plants was devised and sodium silico-fluoride produced. The grade is very satisfactory and the product has the advantage of being reasonably constant in quality. This material bids fair to be substituted for cryolite, an essential ingredient in the type of enamels used on cast and sheet metalware. Most of the cryolite is imported from Greenland, so that the recovered by-product has a considerable advantage in cost of transportation and handling.

Metal Scavengers

MANY metals have been proposed and used as scavengers in the foundry, their function being to prevent the porosity and weakness in castings due to oxides and other impurities. The ideal scavenger is a substance which will remove the impurity-forming compounds by combining with them, and among those which have been suggested may be included titanium, phosphorus, aluminum, silicon, manganese, and boron.

For the best results the amount of scavenger employed should be just that necessary for the removal of the impurities in any given instance, so that no excess, which might affect the properties of the casting, will remain behind. Recently, excellent results have been reported from the use of magnesium, which is very active and will even reduce the metals of other scavengers from their oxides to the metallic state. This is due to its greater affinity for oxygen and at a red heat magnesium combines with nearly all gases with which it is apt to come in contact during melting. The amount required is very small, one-tenth of one per cent being generally sufficient for the complete deoxidation of the ordinary non-ferrous metals. Occasionally with a high percentage of scrap, slightly more scavenger is required.

Laboratory Accuracy

THE accuracy of calibrated glassware, of hydrometers, thermometers, weights, and other items of laboratory equipment, as well as the chemicals and reagents employed, is at the very basis of our scientific work, and it is therefore very important that the effort to assist in perfecting these standard materials is being made by the American Chemical Society through its committee, as announced in the *Journal of Industrial and Engineering Chemistry*. It is believed that a service can be rendered both to the manufacturers and the scientists through proper standardization, and this can be effected through the coöperation of makers and users. That such a movement is important is shown by steps that are being taken both in Germany and England to standardize chemical apparatus and glassware, and it is necessary therefore that the United States become immediately active.

Borax as an Alloying Agent

FOR some time there has been a demand for more information regarding the effect of so-called impurities and the presence of small quantities of the rarer metals upon such alloys as those of brass, copper, and aluminum. There have now been patented alloys of boron which seem greatly to improve various metals from gold to steel. Their use is said to effect great economy in that they have a cleansing and hardening effect upon the metals to which they are added, giving additional strength and rendering alloys more homogeneous and uniform, greatly improving their texture. Castings are said to be more free from imperfections, and one advantage is that ordinarily from 1/10 of 1 per cent to 2 per cent of boronic copper or other boronic alloy is all that is required to obtain results which continue to be beneficial even when the metals are melted as scrap.

Concrete Floor Treatment

EXPERIMENTS continue with various methods for treating the surfaces of concrete floors, principally with a view to preventing excessive dusting. Chemical hardeners appear to be the most efficient. Such compounds as magnesium fluosilicate, sodium silicate, and zinc sulfate give fairly satisfactory results. Aluminum sulfate treatment has given a floor which, after nine months, still remains in satisfactory condition.

Artificial Wool

ACCORDING to a Belgian report, there is considerable interest in Germany in a patent recently taken out on a process for the manufacture of artificial wool. Shreds, short fibers, and wastes are compressed and then immersed in a viscous solution of cellulose or a cellulose compound, with a small percentage of glue. This product is then cut into thin sheets and strips, which can be twisted and spun very much as paper yarn has been manufactured. Waterproofing is obtained by treating the wool in the process of manufacture with compounds of chromium and later with formaldehyde and tannin, after which the product will resist the action of boiling water. Glycerine provides sufficient flexibility, and the Germans claim the yarn thus prepared possesses all the properties of real wool. The process is now being modified so that a certain percentage of paper pulp may be mixed with the woolen waste, after which the product is treated with sulfuric acid and zinc chloride. Various other compounds may be used to give the necessary flexibility and waterproofness.

Spark-Plug Cement

DUE to the high temperature reached in internal combustion engines, difficulty has been met in attempting to seal electrodes into porcelain spark plugs. The reactions taking place in the cement and between the cement and electrode wires, promoting oxidation and consequent destruction of electrode wires, have been one of the difficulties. Again the differences in coefficients of expansion have frequently caused breakage, and if cracks are thus produced in the cement, there is apt to be gas leakage. It is now reported that a simple cement made of silicate of soda and raw kaolin has been found to give satisfaction. Further, in order to avoid any difficulty due to the use of cement, experiments have been conducted with mechanical seals, used at the top of the porcelain, with promising results.

Cellulose Cattle-Food

WHILE crude fiber or cellulose makes up a large percentage of any cattle food, it is only recently that actual experiments have been conducted with foods made by the acid hydrolysis of saw-dust. In connection with the experiments at the Forest Products Laboratory a number of cattle and other live stock are being given various quantities of such saw-dust, in which a portion of the cellulose has been converted into sugar by such treatment. It is reported that cattle find no objection, though horses refuse to eat the material.

In Norway a method of producing hydro-cellulose has been announced. In this a common chemical wood-pulp, usually in the form of cellulose board, is converted into the hydro-cellulose by a treatment with acids, particularly muriatic acid. The method has been described as a fortunate one for solving the question of the technical production of hydro-cellulose, and it is stated that this hydro-cellulose is very advantageous for cattle feed.

Sherardizing

SHERARDIZING is not merely the application of a zinc coating on iron or steel, as is the case with electro-plating and galvanizing. The coating produced by sherardizing is an alloy with the underlying metal upon which the outer layer of zinc is afterwards deposited. The zinc therefore enters into every crevice and cavity, making the process quite different from any other method of zinc coating. The coating is not as hard as it is in the case of galvanizing, for which reason it is considered more desirable for special uses, as where pieces must withstand severe straining and bending and still retain their rust-resisting qualities. It is possible to give sherardized metal a finish comparable to nickel plating or silver plating by buffing on a fine polishing wheel and finishing on a cloth wheel. When so treated, the surface is very slow to tarnish. Time and temperature are very important factors in sherardizing, which should be conducted in a furnace subject to careful control.

Soap Bubbles

WE shall soon have to revise the various sayings which are based upon the supposed absence of value in the soap bubble. In an article on the theory of flotation, Mr. R. S. Williams emphasizes the fact that the forces at work in a soap bubble are of such technical importance that sixty million tons of ore are now annually treated by their application.

Cement Drain-Tile

MUCH of the peace-time work of the Bureau of Standards was interrupted due to the pressure of war work, but some of the important projects have been taken up again. One of these is the field inspection and testing in connection with drain tile used in alkali soils. In Minnesota tile which has been embedded in the ground since the last inspection has been removed, and the concrete found to be unimpaired either by alkali or acids. It is contemplated that a complete survey of all the most important reclamation projects in the West can be made soon, and based upon this work, the committee in charge of the investigation proposed to make definite recommendations relative to the manufacture and use of cement drain tile in our alkali soils.

This oriole's nest is apparently made from a single kite string

A Finished Piece of Bird Architecture

THIS fine specimen of a Baltimore oriole's nest was recently secured from a felled poplar on a residence street in Ann Arbor, Michigan. It is five and one-half by three and one-half inches in size, constructed of hair and string throughout, beautifully pouched, and very firmly and compactly knit together and to its supporting branches. Apparently it is made from a single kite string, quite an incomprehensible and puzzling job to a mere human mind, but a touching monument of the skill and the "joy of the working" of the mother oriole, who is the master constructor of these pensile dwellings.

The name oriole comes from the Latin *aureolus*, golden. The best-known American species, the Baltimore oriole (*Icterus galbula*) winters in Central America, and in summer ranges as far north as the southern provinces of Canada, making the summer mornings and evenings melodious with its musical whistling. Its name was bestowed by the great Swedish naturalist, Linnaeus, whose first specimen came from the then British colony of Maryland, in complimentary allusion to the fact that the colors of the male were similar to those of the bright-hued livery of Sir George Calvert, the first Lord Baltimore, then proprietor of the Colony, and who also gave his name to the city of Baltimore and his coat-of-arms to be its seal.—By *G. E. McDonald.*

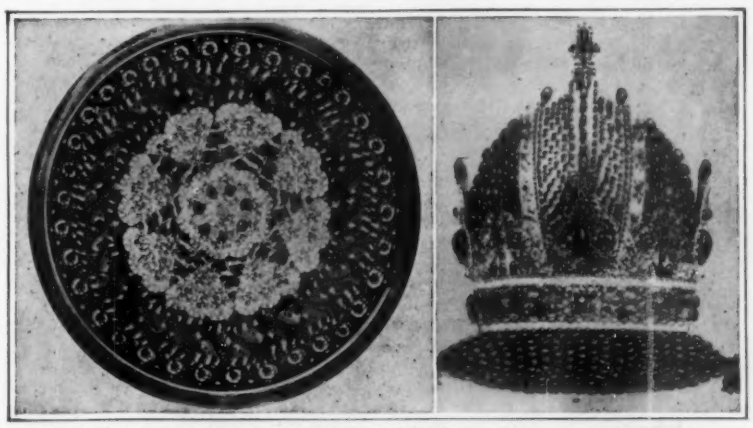
Cement in the Tropics

THE modern style private house in Medan, in Sumatra, Dutch East Indies, is constructed of cement, which material is fast replacing wood for building.

Formerly both tile and stap roofing were most generally used, but with the advent of cement houses, stone and wooden shingles have been adopted. Patent roofings are practically unknown in the Sumatra East Coast, the reason being given that the torrential rains and the great heat militate against their employment. There are very few flat roofs in Medan, the roofs as a general rule having a decided pitch, because of the great rains and because such roofs are said to be much cooler. Stone shingles are becoming very popular, as they are easy to place in position, the shingles being interlocking and, therefore, requiring no cement.

When Insects Become Jewelry

AN organization of enterprising and artistic Germans has taken advantage of the beauty of butterfly wings and insects by converting them into jewelry, wall plates and other ornamental articles. The two accompanying photographs represent the work of the firm in Munich, which has recently popularized this odd kind of art in Germany.



Wall plate made of butterfly wings, and the imperial crown worked out in insects of various shapes, sizes and colors

While there is nothing new in the way of using butterfly wings for jewelry, plates, serving trays, ash trays and so on, it appears from the accompanying photograph of a wall plate that the German artisans have carried this class of art considerably further than has been the case heretofore. The same may be said for the replica of the imperial crown, which is studded with thousands of insects of all colors and shapes and sizes to simulate jewels.—By *Alfred Longville.*

A resting place on the way up Hwa-Shan, and a chain up which a pilgrim is climbing

The Sacred Mountain and the Chinese Pilgrims

EVERY year thousands of Chinese pilgrims risk their lives in climbing up the side of Hwa-Shan, the Flowery Mountain, which is sacred to the Taoist religion. Anyone reaching the temple far above is supposed to have any request granted as a reward for valor and endurance.

The Hwa-Shan Mountain is over 6,000 feet high, and the ascent in many places must be made along a narrow ledge of branches laid on posts driven horizontally into the face of the precipice. There are no hand-rails, but a chain held on the rock face offers some security to the ascending or descending pilgrim. One of our illustrations shows a rest station on the way up the mountain. A pilgrim can be seen climbing up the side of the precipice by means of a heavy chain and the rough steps cut in the rock face. The square hole in the center of the view is a niche for a shrine. The other illustration shows one of the uncertain branch-paved walks on the way up to the summit. There is a sheer drop of 1,500 feet for the unfortunate pilgrim who doesn't watch his step at this point.—By *George Gaulois.*

Cheaper Fuel for Motor Vehicles

DISCUSSION still continues in Australia, as elsewhere, with reference to ways of combating the high cost and scarcity of fuel oil and gasoline for motors and farm tractors. In this connection an article appearing in the *Melbourne Argus* of recent date, giving the views of Mr. C. D. Smith, an English engineer, may be summarized as follows:

Solid fuels offer the only method whereby the high price of liquid fuels can be countered. As an instance, coke, charcoal, and dried peat represent the residue left after the liquid fuels have been extracted.

Mr. Smith gives the distillation of coal in the process of making coal gas as an example and goes on to say that 1 ton of coal would propel a 5-ton steam wagon about 160 miles, the fuel then being completely destroyed. If subjected to distillation the 1 ton of coal would give 13,000 cubic feet of coal gas, and taking 250 cubic feet of this gas as equal to 1 gallon of gasoline, this would propel a 5-ton internal-combustion-engined vehicle 312 miles. But after allowing for the fuel used for the retort about 10 hundredweight of coke would still remain, and at 3 pounds of coke per mile, a 5-ton producer gas vehicle would run a further 373 miles on this, or a total of 685 road miles, as against 160 miles on 1 ton of coal burned directly.

A Sand River that Flows Uphill

THE wind blows down San Gorgonio Pass in to the Conchella Desert Valley in central California. The sand is the waste from the north side of the San Jacinto Mountains and from the south slope of the San Bernardino Range. It falls along the bed of the usually almost dry Whitewater River, forming long reefs and often drifts like snow. During rain run-offs it washes along in quicksand. The gales sweeping through the Pass carry the sand up out of the bars in the bed of the Whitewater and blow it eastward along the foot of the north side of the San Jacintos from across Snow Creek alluvial flats. There it is a veritable sand river, visible for miles across the sage.

The wind bears toward the southeast against the steep, massive spur of San Jacinto peak, carrying the sand in its flow for miles. The cape of the spur juts out to the very bank of the Whitewater River, and a pinnacle on the cape point rises to a height of more than 570 feet above the stream bed. Behind the cape, however, is a sage in the ridge that rises to a height of about 400 feet above the stream bed, and more than 350 feet above the level of the sand river as it comes along the foot of the mountains down the pass.

The cape ridge lies like a dam across the sand river, but the wind carries the sand up the ridge, through the gap and over the summit, where it flies in a vast, tawny cloud out over Blaisdell cañon alluvial fan and on into the Conchella valley toward the Salton Sea, far to the southeast. Much of the heavier grains, of course, drop into the Blaisdell outwash.

For countless years the sand-blast river has washed and worn through the narrows, cutting it deeper and deeper. Millions of tons of sand must have passed that way. The very boulders and cobbles in the way show the attrition and polish of the flying particles.

The approach to the summit through the ridge is somewhat more than half the circumference of an enormous, irregular funnel, and when the wind is on the drive, one could no more face it in the narrows over the ridge than one could face the blast of a high-pressure pneumatic polisher.—By *R. S. Spears.*

There are many such precarious foot-paths on the way up the sacred mountain

The mass of sand flows up this hill under the action of the strong winds

The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGÉ, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles

Unloading direct from car to truck so as to release cars in the shortage of rolling stock

One Step from Car to Consumer

DURING these days of difficulty in securing materials due to freight car shortage, the leading manufacturing and industrial concerns are using every means available to release such cars as have arrived at their plants in order that they may be sent back to other work. A prominent coal company of Detroit is unloading coal from cars directly on trucks in order that these will be held up a minimum of time, as the accompanying photograph shows. A locomotive crane with a crab bucket is used and this takes the coal directly from the gondola cars on the track and drops it into the motor truck body. This system has proven very successful and efficient in delivering the coal about the city, since trucks are driven up to be loaded as fast as the crane can handle them. It will be evident that it does not take many dips of the bucket shown to unload a freight car and have it available for other use.

Transportation and Education

THE question of better educational institutions in the country is beginning to receive the consideration it deserves. The alarming trend of enterprising young people from the country toward the cities, with its resulting harm to the entire country, is constantly under discussion, and solution after solution has been put forth—on paper. A practical correction of this condition must be found, and found quickly. Now the government is about to take a hand, and as a first step it is working for the development of centralized educational institutions in the country, which will do much to make farm life more attractive to worth-while young people.

California is noted for its fine roads, and this gave the local authorities the key to the solution of their problem.

The big bus that brings first-class schools to the farmer's door

A one-ton truck was purchased for the El Cajon Union High School, equipped with a special bus body. This body has one door, with seats arranged cross-wise, and end seats which fold up to leave a passageway. Thirty-one passengers can be comfortably seated. Naturally the services of this truck are required but twice a day—to bring the students to school and take them home. It makes two trips, each eight miles, thus traveling but sixteen miles per day. As school is open but five days, the average per week is eighty miles. Records show that this truck actually consumed but five quarts of gasoline per day—6½ gallons per week—making 12.7 miles per gallon. The Ansheim Union School, which covers a somewhat larger territory, is operating a fleet of several trucks with much the same body construction.

The same plan in various forms is in operation not only in many districts in California, but at widely scattered points throughout the United States. The plan varies in different localities. Some school boards are using adaptable bodies, which do other work on contract during that part of the day when they are not occupied with their school trips and on Saturdays. Other lines are operated by farmers' coöperative trucking companies, which merely handle the transportation of the pupils, at a fixed rate per pupil or per family, as a part of their regular work. In still other places, the work is carried on by some farmer who owns a truck and who increases his revenue and cuts the idle time of his equipment by taking the children of other farmers in his neighborhood to school at the same time that he takes his own, charging a small fare.

It is obvious, with such a scheme, not only that the High School reaches out over a vastly wider territory for its students, but that small communities which have always been dependent upon the "little red schoolhouse" with its single teacher can now coöperate in maintaining a regular graded school.

Wherever in operation, the plan produces not only the result of bringing better and higher educational facilities right to the farmers' front door, but another benefit which is not so obvious at first glance. Not only is the general health of the children improved by reason of escaping the evils of walking to school through all kinds of weather—and walks of three or four miles to country schools are not uncommon—but as a natural consequence the ability to get the most out of the lessons is increased. The children arrive at school fresh and free from fatigue, and naturally are in much better condition to concentrate on their class-room duties.

Hauling a big oil tank by truck

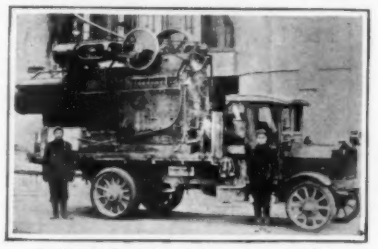
Moving Tank with Truck

VARIOUS articles and illustrations have appeared in these columns showing the tractive power of the modern high powered motor truck and numerous examples have been given to demonstrate that this can be utilized in hauling heavy loads. The trucks used at the Port Arthur, Texas, works of a well-known oil company are called upon to do a large variety of work besides that for which they were originally intended. It is possible to carry on the many odd jobs much more efficiently since the trucks have been introduced.

Any one familiar with moving heavy objects will understand the amount of work involved and time needed to move a large tank such as shown in the accompanying illustration by means of a gang of men or by the usual windlass and horse arrangement. The truck shown not only pulls the tank along as fast as the rollers can be set under it, but it also carries all of the paraphernalia needed for the work. The load of extra blocks, rollers and jacks necessary for the job is just enough to insure proper traction. Considerably more work of this nature can be done by the direct pull of the powerful motor truck in a shorter period of time than can be accomplished by a team of horses pulling on a fall line.

Delivering Limestone by Truck

AT least four Ohio quarries are delivering agricultural ground limestone by motor truck. A charge of 75 cents a ton for the first three miles, one dollar up to 5 miles, and 17 to 18 cents per ton-mile beyond that distance is made by one company. Charges of from 12 to 15 cents a ton-mile are made by other firms. On account of the somewhat hilly and broken country surrounding Bellefontaine, one stone company which operates such a service there, attributes its success to the use of a four-wheel-drive motor truck. With this outfit 4 tons of stone are delivered under almost any condition met. Experience of concerns at Columbus, Lima and Piqua would seem to indicate that ground limestone can be delivered by motor truck, where roads are good, at lower cost than farmers can haul it themselves by any other means.



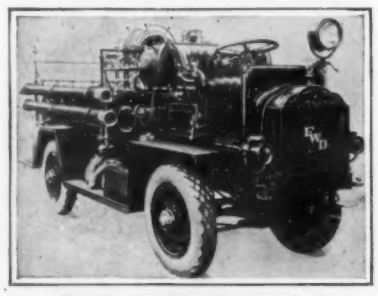
A ticklish job of boiler trucking successfully performed

Truck Hauls Large Boiler

WHEN a firm of big auto-trucking and moving contractors of Toledo, Ohio, were called upon recently to move a 16,200-pound boiler, they chose a truck for the task. The eight-ton boiler had to be hauled to Toledo from Dunkirk, a distance of 70 miles. It was at first questioned whether it was advisable to move the boiler by truck on account of its weight. The truckers finally secured the job on their promise that they would get the truck to Toledo without mishap. The huge boiler was rolled along to its destination as though it were an ordinary, everyday load. The truck that performed the task was not a new one. It had been used for three years, in the hard kind of work that usually falls to a general trucking company, but it handled this rather severe contract without a hitch.

New Combination Fire Apparatus

ANNOUNCEMENT is made of the development of a new 3-ton fire truck by a well-known maker of four-wheel-drive trucks. The new fire-fighting apparatus contains an unusually powerful special motor, with a five-and-one-tenth-inch bore and a five-and-one-half-inch stroke, developing 42 horsepower, S. A. E. rating. Water is pumped by a rotary pump, driven through a two-speed transmission which has a capacity of 500 gallons per minute at 120 pounds pressure and which is located back of the seat. Complete modern fire-fighting equipment is mounted on the body, which is 9 feet long, 4 feet wide and 22 inches deep. Because of the shock-absorbing properties of the large pneumatic tires employed in carrying the load, a speed of twenty-five miles per hour can be maintained without damaging the mechanism. The truck is very compact and because of the location of the power plant under the floor boards in front of the driver's seat it has a short wheelbase, so that it should be easily controlled and readily maneuvered in city traffic. In this respect it contrasts strongly with some motorized fire equipment.



Short-wheelbase fire-truck of new design

Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

METAL SPAR OR GIRDER FOR AIRCRAFT.—E. E. Brown, address D. J. Mooney, care Steel Wing Co., Ltd., 48a Gillingham St., London, S. W. 1., England. The invention has for its object to provide a metal girder which may be lighter relatively to its strength and stiffness than those usually obtained. According to the invention this girder comprising a member of channel-section, is characterized by a series of "embossed" stiffening ribs formed on the web of the girder and disposed at an angle of not more than 45 degrees to lines traverse to the girder and at right angles to the longitudinal direction thereof.

Pertaining to Apparel

GARMENT.—Mabel M. Lauzon, 1030 Dakin St., Chicago, Ill. The object of the invention is to provide a garment which is simple and durable in construction and arranged to permit the user to readily close the garment without the use of hooks, buttons, or similar fastening devices. Another object is to permit of readily opening the dress, and if made of washable material, to allow of conveniently laundrying it.

VEST.—Elizabeth Calkins, 516 N. 7th St., St. Joseph, Mo. The invention relates to a lady's vest and aims to provide a device of this nature whereby the shoulder straps provided with a conventional shirt or vest may be eliminated. The device is particularly intended to be used in connection with evening dress, and may be worn in connection with the corset, and supported by the corset, thus eliminating the necessity for shoulder straps.

COLLAR FASTENER.—J. B. Maxfield, Box 905, Spokane, Wash. The object of this invention is to provide a simple, inexpensive fastener of light resilient material, so shaped that it may be easily engaged with the button hole of the collar and the shirt, which will automatically adjust itself to any thickness of collar or collarband, and will be flat against the neck when in place.

Electrical Devices

ELECTRICAL FITTING.—M. F. Finkelstein, 301 Grand St., New York, N. Y. The object of the invention is to provide a fitting comprising means for connecting the free ends of conductors together with an insulating casing therefor. The device comprises a connector having binding screws for securing conductor terminals, a housing affording access to the screws, and a guard providing protective covering for the screws.

Of Interest to Farmers

VERTICAL CUTTER BAR ATTACHMENT FOR HARVESTERS.—O. P. Williams, Trout Lake, Wash. The principal object of the invention is to provide a vertical cutter bar to operate in unison with the horizontal cutter bar whereby tangled and down hay may be cut loose to permit the driver to see where the cut had been made on his next trip around. Another object is to provide means for transmitting the motion from the horizontal to the vertical knife.

PLANTER.—W. W. Barrett, 1714 14th St., Sacrament, Cal. This invention has for its object to provide a planter adapted to either garden or field planting wherein means is provided for picking up a predetermined quantity of individual seeds, as for instance one or more, and delivering them to a furrow opener or the like to be delivered to the furrow.

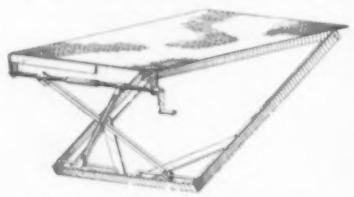
Of General Interest

FOUNTAIN PEN.—J. E. Hayes, 68-70 Barclay St., New York, N. Y. The object of the invention is to provide a gold pen point so constructed as to adapt a fountain pen for duplicating work, the pen point being such that an ink line of uniform thickness can be made irrespective of excessive pressure applied to the pen in writing, and furthermore to provide a pen possessing a certain springiness without the fault of spreading at the nib beyond a predetermined degree.

FILM CLIP.—J. G. Hartlieb, 3410 Park View Ave., Oakdale Sta., P. O., Pittsburgh, Pa. The invention relates to a clamping device to be used in connection with photographic films; the object is to provide a clip which securely clamps the two ends of a film holding the ends apart and permitting the film to be easily supported in the developer or wash during the process of development. The clamping device is preferably made of sheet steel with a resilient handle connecting the jaws.

LOCKING DEVICE FOR FRAMES OF BAGS, PURSES AND LIKE ARTICLES.—M. T. Goldsmith, 811 So. 13th St., Newark, N. J. The object of the invention is to provide a locking device for the frames of bags, purses and similar articles and arranged to securely hold the frame locked when in closed position with a view to prevent accidental or surreptitious opening of the frame and abstraction of the contents by unauthorized persons.

BED REST.—A. Hackman, 839 N. 8th St., Allentown, Pa. The invention relates to bed rests, an object being to provide a rest which may be located at the desired angle, and which



A PERSPECTIVE VIEW OF THE DEVICE

may easily be adjusted from one angle to another by the use of a screw threaded rod and crank handle, and securely held at any point of adjustment, and which when not in use will occupy but a small space.

LAMP SHADE.—I. B. Beales, 356 Harrison Ave., Hasbrouck Heights, N. J. The invention has for its principle object, to permit the shipment of shades of the character mentioned in compact form, to provide means for readily assembling the separable parts of the shade, to provide means for connecting the separable elements in close relation to avoid rattling, and to simplify and reduce the cost of construction.

BROOM.—S. Canton and H. Gonen, 310 E. 51st St., New York, N. Y. Among the objects of the invention is to provide a broom having a reversible, double-ended broom body to insure long life to the broom. Another object is to permit of conveniently removing a worn out body and replacing it by a new one, and to render the broom exceedingly economical by using the same handle frame with a number of broom bodies.

COAT PROTECTOR.—H. Schachne, 1116 Hoe Ave., Bronx, N. Y. This invention relates to appliances for polishing metal buttons or the like for uniforms, and has particular reference to a device adapted to be placed around and beneath the button while sewed or otherwise fastened to a coat or other garment, whereby the polishing materials are kept from coming into contact with the fabric.

FASTENING DEVICE.—G. S. Solomon, Box 2153, Bisbee, Arizona. The object of the invention is to provide a fastening device for securing and quickly fastening fence posts, telegraph posts, telephone posts and other posts to foundations such as concrete blocks. Another object is to insure a tight joint between the bottom of the post and the top of the foundation, and to permit removing the post from the foundation without disturbing the foundation block.

BALLAST BAG FOR SCENERY.—C. A. Salisbury, 61 Ann St., New York, N. Y. The invention relates to clock receptacles, and pertains more particularly to canvas bags used as ballast for stage scenery and settings. These bags are intended to be filled with sand, and are held suspended, therefore one of the objects is to so construct the bag that it will be capable of withstanding the great strain to which it is subjected.

Machines and Mechanical Devices

MACARONI DRYING PLANT.—G. Gentile, 4251 West Pine Bldg., St. Louis, Mo. Among the principal objects of the invention are to provide means for maintaining a continuous circulation of dry air in the presence of suspended macaroni, to provide means for it while reversing the direction of the blow of air utilized, to provide means for removing the heavier or humid air, and to thus reduce the time required for drying the macaroni.

CHECK TURNING DEVICE.—E. Albaugh, care West End Lumber Co., San Antonio, Texas. This invention has for its object to provide a device of the character specified especially adapted for turning checks or the like accurately and rapidly under control by the operator, it is especially adapted for use by adding machine operators. The machine as a whole is operated by a motor and mounted upon a suitable table.

CLOTH LAYING MACHINE.—G. Soylian, 221 Atlantic Ave., Brooklyn, N. Y. The invention has for an object an arrangement which will automatically lay any desired length and thickness of cloth quickly and accurately. A further object is the provision of an arrangement which will grip the ends of the cloth as the cloth is laid and will also automatically shift the laying mechanism according to the thickness of the laid cloth.

CLUTCH.—O. A. Jones and J. T. Fairbourn, Bacchus, Utah. The invention relates to clutches in which movement of a drive shaft is transmitted to a driven shaft through the medium of a liquid and in which means is provided to control the circulation of the liquid to regulate the transmission, and to facilitate and simplify the control and adjustment.

BOX MAKING MACHINE.—W. Hughes and O. R. Bieler. Address Frank J. Higgins, 15 Exchange Place, Jersey City, N. J. Among the principle objects of the invention are to increase the number of boxes which may be produced in a given time, to reduce the cost of producing, to reduce the quantity of material used in the manufacture and to provide a smooth running machine for performing the operations necessary to produce the boxes.

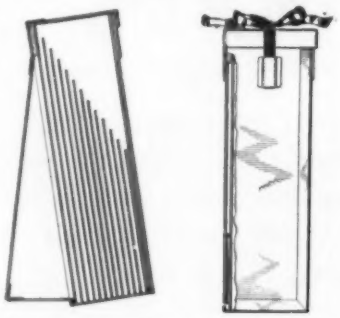
ORE SEPARATOR.—R. J. Piersol, 160 W. College St., Canonsburg, Pa. This invention relates to machines for concentrating ores, by what is known as the "flotation process." In this process the pulp which embodies finely divided ore, a liquid such as water, and a frothing agent of a suitable oil, is subjected to agitating and aerating; the prime object of the invention is to increase the efficiency of this agitating and aerating process.

Medical Devices

SURGEONS' PLASTER KNIFE.—H. B. Philips, 2178 Broadway, New York, N. Y. The invention has particular reference to means for removing a plaster cast from a limb after it has been set and healed. Among the objects is to avoid the usual difficulty in cutting or slitting the cast without danger of cutting the patient, for this purpose the invention provides a device, including in addition to one or more blades, a member acting as a breaker or reducer of the structure of the cast adjacent to the slit or cleavage formed by the cutting device.

Musical Devices

HOLDER FOR DISK RECORDS.—F. Grammich, 499 Vandervoort Ave., Brooklyn, N. Y. This holder is adapted to be made from cardboard and to contain a dozen records of either ten or twelve-inch size. The holder has a form and dimensions adapted to be placed on the shelf of a phonograph cabinet,



A LONGITUDINAL VERTICAL SECTION AND END VIEW, PARTS BROKEN AWAY

and it has a novel means at the back to rest it on a table to afford convenient access to the records, arranged in stepped form, so that with the opening of swinging doors at the front, and normally closed by the hinged top, the records are readily accessible and may be conveniently removed and replaced, and the holder quickly closed.

Prime Movers and Their Accessories

CARBURETOR.—C. V. Elliott, R. R. No. 2, Lathrop, Mo. The general object of the invention is to provide manually controlled means whereby the inlet valve of a carburetor may be depressed, but, additionally, to provide means causing the automatic closing of the valve before the carburetor can overflow. A further object is to provide means whereby a yielding pressure may be exerted on the float to yieldingly hold the float down below its normal point of buoyancy, but which, when the liquid has risen to a predetermined point will permit the float to rise and close the inlet valve.

Pertaining to Recreation

TOY.—C. W. Oberreich, 414 So. Spring St., Bucyrus, Ohio. The object of the invention is to provide a wheeled vehicle having means for steering the same, together with a seat rockably connected with the body and normally spring supported, and connected to the wheels in a manner to cause the seat to be rocked when the vehicle is propelled by the feet of the user to simulate the rising and falling movement of a horse.

Pertaining to Vehicles

RESILIENT WHEEL.—H. S. Bauman, 826 3d Ave., N. Nashville, Tenn. The invention has for its object to provide a wheel in which the required resiliency is acquired without the use of ordinary pneumatic inner tubes. A further object is to provide a wheel in which an ordinary outer casing may be used, held extended by a series of shoes within the casing cushioned by air confined within the hub. A still further object is to provide a wheel of durable construction by preventing the overheating of the tire casing.

VARIABLE STEERING DEVICE FOR VEHICLES.—R. de Filippis, 435 Rodney St., Brooklyn, N. Y. The invention relates to toy vehicles, but certain features of the construction are adaptable for a wider field of usefulness. Among the objects is to provide a steering drum mounted on a horizontal axis parallel to the rear axle of the vehicle and driven from the rear axle, said drum being provided on its periphery with a plurality of grooves in any one of which the steering lever may be selectively adjusted to turn in either direction from the normal straight away.

PNEUMATIC TIRE.—E. G. Fido, care Thos. Cook & Son, 245 Broadway, New York, N. Y. The invention has for an object to provide a tire in which the casing is formed with separate segmental chambers, each having its individual inner tube and tire valve, to facilitate the insertion and removal of the individual inner tubes and to provide means to close rim openings of ample size through which the inner tubes and valves are inserted, the closure means being effective in maintaining the valves and parts in position whether the inner tubes be inflated or deflated.

AUTO CAB.—J. Anderson, 3940 Brooklyn Ave., Seattle, Wash. This invention relates to an auto-cab body and aims more particularly to provide a device of this nature which may be applied to a motor chassis and be readily removed. A further object is to construct a body which may be collapsed when not in use, so as to occupy a minimum of space for storage purposes.

WATER CIRCULATING PUMP FOR COMBUSTION ENGINES.—O. T. Scharmann, Marshfield, Wis. The invention relates generally to water circulating pumps, but more particularly to a specially constructed pump for use in connection with Ford automobiles to replace the thermosiphon action ordinarily present, with a force feed action, and with minimum disturbance of the parts usually present in connection with such cooling systems.

The Scientific American Monthly for June

DID the Babylonian astronomers possess telescopes? The question is asked by Dr. Heinrich Hein who calls attention to a prophecy written in cuneiform letters which was discovered a few years since. The prophecy starts with these words: "When it cometh to pass that Venus hideth a star with her right horn. . . ." How could the ancient astrologer have known that Venus passes through phases similar to those of the moon? Dr. Hein shows that a telescope can be made with a single convex lens and it is barely possible that such was the instrument of the ancient astrologer. The ancients possessed lenses which they used as burning glasses. They also knew how to construct magnifying mirrors which were used, as they are today, for shaving; it may be they had reflecting telescopes.

Three new uses for the airplane are described in the current issue of the MONTHLY. Dr. Ford A. Carpenter, Manager of the Department of Meteorology and Aeronautics of the Los Angeles Chamber of Commerce, tells of his journeys in an airplane for the purpose of photographing clouds. The article is illustrated with unusual and very interesting photographs. Under the title "A Pack Train of Eagles," Eugene Shade Bisbee suggests the use of airplanes in mining operations where roads and trails are absent. He demonstrates that under certain conditions material savings could be effected by employing airplanes in place of mules and horses for the transport of supplies to the mine and the transport of ore from the mine. The U. S. Bureau of Mines is looking into the possibility of utilizing airplanes in conjunction with its rescue work for the quick transport of engineers and oxygen rescue apparatus to mine disasters. The prospects of such use of the airplane are discussed in an article by F. J. Bailey, Assistant to the Director.

Under the title "Looking Through the Phonograph Record," Francis F. Lucas tells of his microscopic search into the causes of surface noise in phonograph reproduction. He shows that the structure of the material from which the record disks are molded is a most important factor. In one case tiny mineral particles were discovered which were traced to the stone mill in which the wood flour used in the record material was ground. The article is illustrated with many interesting photomicrographs.

In view of the price we have to pay for shoes today considerable interest attaches to the article on leather and the process of tanning hides by Robert G. Skerrett. As a rule the shoe manufacturer is more concerned with the appearance of the leather than its lasting qualities. He seldom analyzes sole leather for possible adulterations. The modern art of tanning falls short of the standards set in days gone by. It used to take two years to convert "green" hide into marketable leather; the modern tanner thinks that he is doing well if he devotes five months to the process. No chemical process has been developed of speeding up the process without detracting from the quality of the product.

Under the title "Peat as a Possible Source of Industrial Power," Mr. Herbert Phillipp discusses the economic factors involved in the competition of this fuel with coal, and concludes that there are no difficulties in the way of using peat for steam raising as a powdered fuel or using peat in a gas producer. "Three New Sources of Fuel Alcohol" tells how this product is obtained from molasses, wood waste and acetylene.

There are twenty-five titles of main articles in the current MONTHLY together with a large number of notes and short items. In addition to the regular usual departments there is a new one entitled "Notes on Science in America," which is edited by Edward Gleason Spaulding, Professor of Philosophy, Princeton.

Duluth to Liverpool in One Bottom

(*Continued from page 670*)

seas. This entails not only much additional handling, but it involves a good deal of increased expense. If ships could load on the Great Lakes and steam thence to their destinations across the Atlantic without further to-do, under normal conditions grain could be landed in Liverpool, for instance, for five cents less a bushel.

According to the engineering estimates, our part of the proposed undertaking would not involve an outlay of more than $60,000,000 on the St. Lawrence, and $100,000,000 would cover that work as well as the necessary channel and canal improvements needful to provide ample passageways for sea-going freighters trading with every first-class port on the Great Lakes. This sum does not loom large if we bear in mind that the State of New York has already spent on its barge canal system a matter of quite $150,000,000. But other material benefits of an economic nature would accrue to us through our participation in the damming of the St. Lawrence. The outpouring waters from the enormous reservoirs of the Great Lakes would furnish our side of the St. Lawrence with motive force capable of developing substantially 1,000,000 horsepower of electrical energy. Converted into terms of coal burned in steam generating plants, this water-developed power would represent each twenty-four hours a saving of 36,000 tons of fuel. Changing our potential million horsepower into electrical units we have 750,000 kilowatts, which at Niagara Falls rates of $20 per kilowatt-year would produce a yearly revenue of $15,000,000. If coal were burned to develop continuously so large a block of energy, the cost in the course of a twelvemonth would amount to $65,700,000.

The hesitating taxpayer may be inclined to ask: "Do we really want this volume of potential horsepower—do we need it?" Census figures covering the period between 1889 and 1917 should satisfy the doubter and, at the same time, point to what will certainly be required in the course of the next five or ten years. The installed capacity of prime movers in central stations, manufacturing establishments, and the power plants of electric railways throughout New England and New York State amounted in 1900 to 12,270,000 horsepower. By 1910 this total had reached 21,200,000 horsepower, and today the aggregate of these plants represents fully 27,200,000 horsepower. By 1925 this great industrial region will need installations totalling 30,100,000 horsepower, and ten years from now, at the present rate of increase, installations will be called for capable of a maximum development of 33,000,000. And it should be borne in mind that this array of figures does not include the horsepower of locomotives and thousands of isolated steam plants now meeting the demands of widely varying services.

It is true, of course, that navigation between the Great Lakes and the Atlantic would be halted during four months of the winter period, but during the eight months remaining a tremendous tonnage could be moved via this route to and from our intensely productive interior section. The immediate and the reflex economic gains due to this new highway of commerce cannot be comprehensively evaluated in mere dollars and cents. In the winter time, many of the ships that might be employed in the Great Lakes-ocean trade could shift their activities to the Atlantic seaboard. The project in its entirety reasonably promises to deal with the peak-load period of seasonal freights and to lend itself potentially to the general stabilizing of our internal traffic system. Incidentally, it will promote the upbuilding of vast stretches of territory and bring in its train social, industrial, and economic readjustments of primary importance to the whole country.

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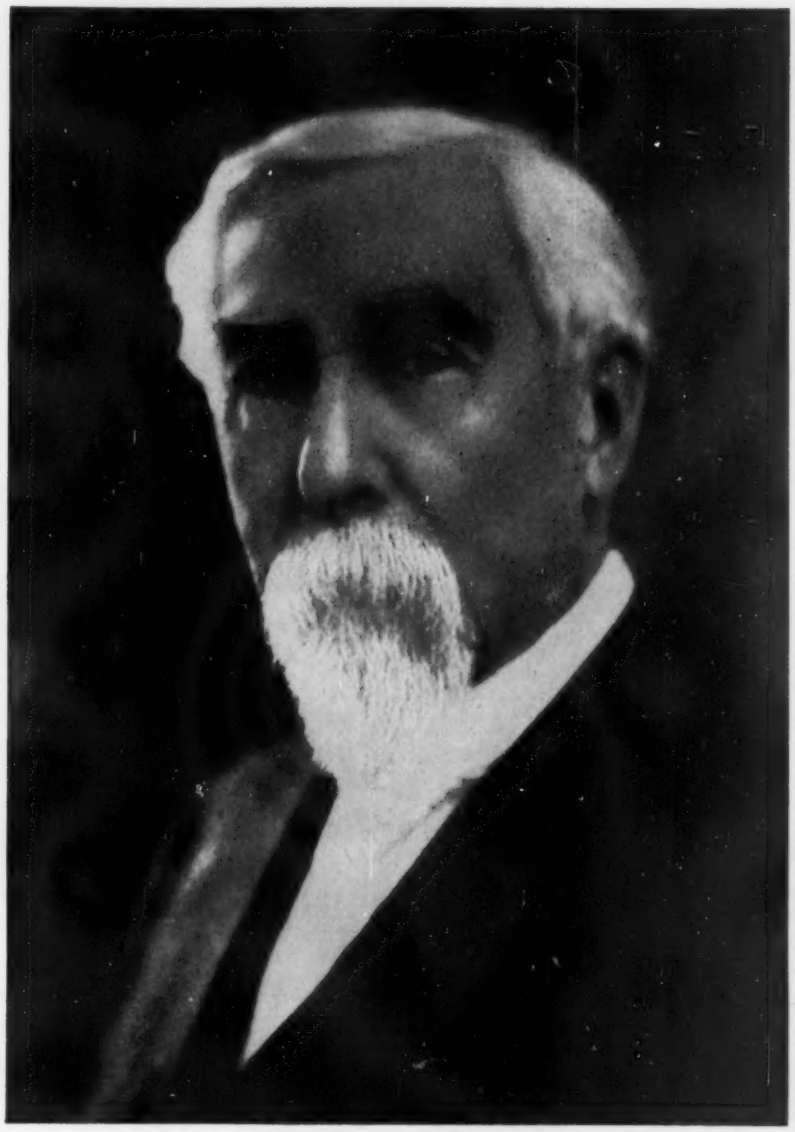

Henry M. Leland
President Lincoln Motor Company

A Builder of Motor Cars: a Moulder of Men: a Master of Craftsmanship: a General of Organization: a Man whose Standards, and Methods, and Ideals have been Models and Inspirations to the Industrial World

HENRY M. LELAND has been called the father of Detroit's motor car industry.

For more than thirty years he has been recognized as one of the world's master craftsmen, and as a leader in mechanical industry—with a record for doing things—and doing them better than they had been done before.

He is known as a man to whom achievement has been a source of greater satisfaction than has monetary gain.

Mr. Leland comes of rugged New England ancestry, and in New England his earlier life was spent.

There he left the imprints of his genius, and his skill, and though many years have passed, those imprints still remain—undimmed.

In the year 1890, he came from New England to Detroit, where for a number of years he engaged in the manufacture of the finer kinds of machinery and precision tools.

He was one of the pioneers in the manufacture of gasoline marine engines.

Eighteen years ago, Henry M. Leland with Wilfred C. Leland, and their associates, brought out an automobile—the first practical and enduring car made in large numbers.

That was followed in almost annual succession by cars embodying intrinsic betterments, greater comforts, greater conveniences and greater utilities. These in their turns became important factors in directing the trend of motor car development.

As an outstanding example of Leland foresight, courage and initiative, one has but to recall their pioneering of the electrical system of starting—lighting—ignition. And where can you find a car that has not followed that lead?

It has been not only a Leland policy but a Leland principle, never in their products to adopt a feature whose worth did not extend beyond its value as a "talking point".

They were Leland-built cars that were awarded the Dewar Trophy—the trophy awarded annually by the Automobile Club of Great Britain to the motor car demonstrating the greatest advance in the development of the industry. Leland-built cars were the only American product ever to receive that wonderful and much-coveted tribute—and the only make of car thus honored twice.

Few places there are in the automotive world but where the Leland influence has permeated; few but where their codes and their methods have been models, and where their standards have been an ideal and an inspiration.

Always unselfish, access to their ways of doing was as an open book. Always have they given freely of their encouragement to the motor and other industries who sought their counsel.

Notwithstanding each car was a greater car than the car before, the Lelands seemed always to be inspired by an insatiable desire to achieve and to surpass.

The latter part of 1914 marked what was, up to that time, the crowning achievement of their career.

It was then that the Lelands gave to the world the first eight-cylinder, V-type, high-speed, high-efficiency motored car. The effect and influence of this car upon the industry is too well known to call for comment here.

The elder Mr. Leland (Henry M.) insists that to the younger (Wilfred C.) is due the credit and the honor for the conception of that fine car.

July 1, 1917, the Lelands withdrew affiliation from the motor car industry, that they might engage in the production of Liberty Aircraft Motors for the Allied fighting forces.

Those who know the character of the men, know that something besides financial gain was responsible for their decision.

The epoch making history that followed, and the tremendous task involved, would require volumes to relate; but briefly:—

The Lincoln Motor Company was formed, and on August 31, 1917 was awarded a contract to produce 6,000 Liberty motors; later, this was increased to 17,000. And the Leland reputation for doing things in a big way—and doing them right—was the predominant consideration in making that award.

Fifty-two acres of land were acquired; an adequate plant was erected and equipped with thousands of specially designed machines and tools.

An organization, meantime, was assembled; its backbone was composed of men who had been associated with the Lelands from three to twenty years or more. They knew the character of their leaders and they were anxious to enlist under the Leland banner.

After one year's development and with 6,000 employees, the Lincoln Motor Company was producing at the rate of 50 motors a day.

Notwithstanding past accomplishments, the Lelands have long looked forward to even greater things. They have looked to the day when they might build a motor car that would be a more true expression of their own ideals—ideals to which the new conditions more completely lend themselves.

And now, that day has come.

For years, that ideal car has been taking form, and is about to materialize.

It is a car which, like the Lelands' past achievements, is destined to blaze new trails and to chart the course of fine car making.

LINCOLN MOTOR COMPANY DETROIT, MICH.

What Goes On Inside a Gas Cylinder

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from the rotating mirror may be moved across the ground glass once for each revolution of the engine. Just at the point where the beam of light reaches the limit of the glass screen, the next succeeding face of the rotating mirror engages the beam of light and simultaneously reflects it to the opposite end of the glass screen. In this way the pressure-time relations with the engine cylinder for two revolutions, or one cycle, are rendered visible on the ground glass in the form of a pressure-time card.

It should be explained that, for taking pressure-volume cards, a synchronizer is provided, which oscillates the eight-sided mirror within the motor box in synchronism with the reciprocating motion of the engine piston.

We present two cards, one a conventional pressure-volume card, and the other a normal pressure-time card, both taken on a Midgley Indicator.

The conventional indicator card shows the relations between pressure and volume in the engine cylinder; but the pressure-volume card is not well adapted for making a study of the phenomena occurring during the combustion in an internal-combustion engine. The reason for this is that ignition and combustion occur when the piston is close to top dead center, during which time the horizontal movement along the pressure-volume card is so small that pressure changes are recorded merely as a single vertical line. The pressure-time card is preferable because the movement along the horizontal or time axis is always uniform, thus making pressure changes clearly distinguishable.

Photographic indicator cards are obtained by holding a sheet of bromide paper against the glass front of the motor box. By pushing a button, the voltage of the light circuit is increased for exactly two revolutions of the motor, and the result is a sharp black line on the photographic paper.

What is Wrong with Our Paper Supply?

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the drive to prevent stretching the paper and tearing it as it passes through the machine. The difficulty has been met in several ways. One form of drive is by a train of gears, each gear being provided with a friction clutch to provide flexibility. Another form of drive is by rope pulleys. In either case there is a limit to the possible speed. A new form of drive has just been devised using synchronous motors with a special control mechanism to govern the speed.

The machine is divided into sections and each section is driven by an individual motor. The speed of each motor is carefully adjusted and controlled to a fine degree of accuracy by the special control mechanism. Recent installations of this type of drive have shown that it gives the mill an almost unlimited range of speed, permitting the machine to be run at all times at the highest speed the pulp will permit.

It is possible this invention will relieve, in some degree, the present shortage by speeding up existing mills which have a good pulp supply available. Wherever possible paper mills have been located near water falls so that a supply of cheap electric power is available, making the motor drive most practical.

Woods similar to spruce, such as fir and pine, are sometimes used for pulp, but the resin in them fouls the machinery to such an extent as to halt operations frequently. Materials other than wood cannot be used economically in the sulfite process because of their light weight for the bulk involved. Thus cotton stocks have been found to produce a good sulfite pulp but only one-fourth the weight of cotton stocks, as compared with spruce, can be put in the digester at one time. The same amount of chemicals and cooking are required, so the treatment cost is about four times as great for a given quantity of pulp. The cost of collecting the cotton stocks also is prohibitive and it is doubtful if a sufficient supply could be had.

Experiments are being made now with a species of southern grass, but the same objection applies in the making of sulfite pulp. It is possible, however, that a substitute for ground wood will be developed from this or a similar source. Great quantities of the grass are available in our Florida swamps. But here another difficulty is encountered. There is no coal or water near the grass supply and it takes nearly as much coal as pulp to produce a ton of paper. So it would probably be more economical to haul the grass to the present northern mills than to build new mills at the source of such a supply.

Scientists at Columbia University are conducting a series of experiments with bamboo as a substitute for spruce in the production of book papers. Bamboo grows very rapidly in the tropics so that a paper mill located in the center of a bamboo forest would have a perpetual supply by rotating its cutting operations, with the plant as the center of a circle. There is good assurance of the ultimate success of these experiments.

Bamboo pulp produces a fair quality of book paper and there is the possibility, as our knowledge of the methods of making bamboo pulp improve, that one day our paper industry will be transferred largely to the tropics and that our newspapers will be printed on quality of paper equal to that now used in magazines. The paper may cost even less than ordinary newspaper, such as we know it now. Another angle of the problem in which a little work has been done is the reforesting of the lands devastated by our present mills.

Relief might come from still another source. As noted above, the chief reason many other woods cannot be used instead of spruce is because of the resin in them. Fir, for instance, has an appearance very similar to spruce, both in the tree and in the board, but it cannot be used, except to a limited extent, because of the resin in it. If some economical method of extracting the resin could be found, fir and other woods would be made available and the supply of raw material multiplied many times. This, however, seems a rather forlorn hope.

In fact, with the exception of the new electric drive for paper machines, none of the possible remedies for the situation reviewed here offers hope for any immediate relief. The chief reason is the skepticism of the paper industry itself as to new schemes. Too many of them have already been tried with no results and any new method that finds general adoption will first have to be demonstrated by some venturesome soul in competition with the established methods of the industry.

But it is the history of invention that whenever a great need arises, there usually is found a way to meet it. It would seem that this is the psychological moment for the introduction of some revolutionary idea or invention in the paper industry. Indeed, now that the problem is being tackled by real scientists in a serious way, it is not at all a wild guess that some way out of the "blind alley," in which the paper industry finds itself, will be discovered within the next few months or years.

Until some new material or method has actually been demonstrated it would be worse than folly—almost suicide—to continue our course of cutting off our only source of raw material—spruce forests—without reforesting.

As for the immediate future—the next year—there seems little chance of escape from the present paper shortage and possibly higher prices.

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quire a tunnel of huge capacity. Also it becomes necessary to take extreme precaution lest this become obstructed with drifting material and to avoid direct communication of the vitiated air of the sewers with the ambient of the city.

There is in Caracas a circumstance that peculiarly favors the establishment of a network of sewers—the sharp declivity of many of its streets; but, on the other hand, there exists an area where there have been formed a certain number of deep ditches, or ravines, which constitute a natural means of drainage for a great part of the city. These serve as secondary collectors. If these were to be provided with two marginal sewers to assemble the product of the respective cavities, it would be conducted to the chief disposal terminus of the network. It has been thought to employ one or the other of these systems, as local conditions might justify and determine. With respect to the transversal dimensions of the secondary collectors, these have been calculated according to the circumstances of each case, or with a view to assembling all the rain-water that there develops, or, in the case of the marginal collectors, simply to drain the particular allotment of houses to be served.

For the rest of the sewers of the city there has been adopted in general the circular form, since the question here served is that of a major area for a given perimeter, with the exception of the three largest types. For these there has been preferred, for the relative facility its execution affords, the rectangular section, with the inferior corners rounded and provided a coating of reinforced concrete.

A high sense of civic idealism and responsibility was manifested in the principles and motives that actuated the Ministry in undertaking, on behalf of the Federal District, the construction of the big aqueduct system by which the water supply of the city has been markedly amplified and in every way bettered, as to original sources, protection of the flow and ultimate distribution to householders and business establishments. The system has but recently been completed and cost more than 2,000,000 bolivars.

One of the main divisions of the aqueduct system is the Macarao drainage. The operations that have brought to a head that part of the Caracas aqueduct may be divided into works of two distinct characteristics—the laying of syphons of tube steel and the construction of the erstwhile drainage with a support of reinforced cement.

Considerable importance attaches to the fact that at no time during the building of the system was it necessary to interrupt for even a single day the regular supplying of water to the city, a circumstance attributable to the employment of parallel auxiliary canals of galvanized iron imported directly from the United States and that proved to be of maximum efficiency as temporary carriers. The total cost of the work was 2,263,234.65 bolivars ($452,645.93).

All of the steel and manufactured material used in the aqueduct construction was brought to Venezuela from the United States. At the outset of its operations, the Ministry of Public Works adopted steel tubing because of its greatly reduced expense and the major facility it afforded for its transportation from the States and for its placing in position upon arrival at Caracas. A type of asphalted tubing known as spiral riveted pipe, manufactured at Newburgh, N. Y., and provided with bolted joints, was specifically requisitioned.

By virtue of syphons the total length of the original canal, which was of 45,800 meters (147,400 feet), was definitely reduced to only 31,335 meters (94,000 feet), with consequent economy in the expenditure of both time and money. Owing to the fairly indefinite duration allotted the reinforced cement, as against approximatel twenty-five to thirty years that the steel material of the syphons is figured to last, the Ministry is considering the application of this principle to other important sections of existing aqueducts that serve the capital city, it being held by the engineers that, in order to leave the aqueduct an accomplished fact for an indefinite period, it is advisable to reconstruct with reinforced cement the divisions of the original canal that have been discarded and so prevent the possibility, however remote, that the syphon tubes might become disabled and out of service.

The tubed sections referred to being relatively short and of small diameter, they may be easily substituted for other tubes, so much more when the corresponding sections of tubing cross a terrain of very uncertain character, furrowed by numerous ditches and ravines, where it would be alike difficult and costly to maintain a concrete canal such as might there be constructed.

It will be sufficient to cite the case of the beautiful Avenida 19 de Diciembre, one of the city's smartest thoroughfares, to reveal the ultimate economy that has been realized by the policy of street and road betterment encouraged by the Federal District Government and put into practical execution by the Ministry of Public Works. This splendid boulevard is the rendezvous for automobiles, equipages and equestrians. It was constructed with a good macadam system and lastly was well petrolized, and for this reason it is preserved and maintained in excellent shape, necessitating today only the simplest cleaning of its surface and of its sewers for the discharge of their overflow.

Such attractive companion paralleling and intersecting thoroughfares as the Avenida San Martin, the Avenida Carabobo, the Avenue del Paraiso—the latter the "Rumson Road of Caracas"—have been improved under similar conditions, with slightly varying circumstances according to physical conformation and environmental topography and drainage capacity, while the older and narrower streets of the city all have undergone radical improvement by re-basing and repaving, and, in some cases, re-grading and widening at formidable costs, especially where the tracks of the well maintained tramway system have had to be removed and re-laid.

Automobile and vehicular traffic has been quick to seize the advantage that this street-betterment offered, and one now may pass into and out of Caracas and through its wonderfully picturesque thoroughfares with no hesitancy or fear of damage to cars or tires. In the more frequented streets of the shopping and business section, such as the vicinity of the Cathedral and Plaza Bolivar, traffic is regulated by police stationed at the principal crossings.

Under a law enacted by the Venezuelan Congress June 26, 1913, there was created for the Republic an administrative division styled the *Direccion de la Sanidad Nacional.* Among the sweeping reforms sought by the new director is complete dismantling of the existing antiquated toilet facilities of dwelling, store, factory and hotel—if anything they are more truly pestilential in the latter institutions than elsewhere—and the substitution of modern equipment to be brought from the United States.

Stringent milk-inspection, vaccination, recording of vital statistics, garbage disposal and anti-spitting ordinances have been promulgated by him, with the unswerving support of President-Elect Gomez. One of the most recent innovations has been the building and establishment at Rincon del Valle, in the southern environments of Caracas, of an *asilio de aislamiento,* or isolation hospital,

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equipped with the latest laboratory and sanitation apparatus. With the roofing, screening and all the beds and bedding and most of the kitchen equipment imported from this country, the new hospital presents a veritable model of sanitary efficiency. It will be the scene henceforth of the searching investigation and analysis of all diseases of a contagious or malignantly venereal character reported from the Federal District and from nearer interior sections.

When the Heart Tells Its Story

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in a record which shows in a rather remarkable way the result of laughing during a test. The record, then, is not a simple record of heart action, but a complex record of every muscular movement going on within the body, and a superficial study is of very little practical value.

Credit for the development of the machine cannot be given to any one man. The Einthoven string galvanometer has been in use for many years. An instrument of design very similar to that described here was used during the war by the French army for range finding. The particular instrument pictured here was designed and constructed in New York.

Principles successfully utilized in similar machines could be applied to give a moving record, in appearance very similar to the records shown here, on a darkened screen, for use in the operating room. The screen could be properly shaded so that the record would be visible even though adequate light for the delicate work of the surgeon could be had. It is probable that the surgeon himself would not watch the record, but it would serve as an indicator to an assistant or to the person administering the anaesthetic. The surgeon might wear a telephone receiver, to which the amplified body currents were conducted, so that he could "hear" the patient's vitality.

The heart beats would be of such low frequency, however, as to be inaudible except as "clocks" in the receiver. The smaller vibrations, however, would perhaps produce a definite tone and with the development of the art, these may be found to be very important indicators to the operating surgeon.

Medical authorities have already begun a serious study of the possibilities of the instrument and some interesting developments may be expected soon.

Grinding of Wood from Young and Old Trees

GREEN or freshly cut wood is known to yield a more desirable ground wood pulp than seasoned wood. It is not unnatural to assume, therefore, that a similar difference might occur in the grinding of wood from very large trees, which contain a large proportion of heartwood, and smaller trees of the same species. This assumption has been verified by the Forest Products Laboratory, at Madison, Wis., in a series of commercial grinding experiments on wood from large and small white fir (*Abies concolor*), grown in Plumas County, California. Paper was afterwards made from the pulp on the laboratory machine, and tested for strength and color.

The small or young wood was cut from trees 18 inches or less in diameter, and the large or old wood was split from a single tree 40 inches in diameter and 130 feet high. Under like grinding conditions, the actual solid volume of old wood ground was, in every instance, appreciably less than the volume of young wood ground in the same time.

In brief, the tests demonstrate that (1) there is a considerable difference in the quality of pulp produced from white fir, depending upon whether the wood is taken from old or from young trees, and (2) the advantages as regard production, power consumption, strength, and color are all in favor of young wood.

As the average ground wood pulp from white fir was found to be darker or duller than is desirable for many grades of paper, it is entirely possible that a provision for sorting the young wood and grinding it separately from that taken from large trees would result in improving the color and quality.

Industrial Status of Asia Minor

SMYRNA suffered very severely from the blockade measures of the Allies. Cut off from its usual markets and possessing only a very costly land communication with Constantinople, many of its main exports have ceased for nearly five years. As a result there were on hand at the close of the war large stocks of staple articles ready for shipment, such as carpets, opium, tobacco, licorice root, valonia, chrome, emery, etc.

It was, therefore, more fortunately situated than the other districts affected by the war in that it had on hand actual products which it could exchange for goods from America. According to a compilation made by the United States Department of Commerce commodities available for export on February 20, 1919 were: Tobacco, about 15,000,000 kilos; cotton, 4,000,000 kilos; silk, 125,000 kilos; valonia, 10,000,000 kilos; gum tragacanth, 140,000 kilos; mohair, 3,000,000 kilos; fresh skins, 1,800,000 pairs, and unwashed wool, 450,000 kilos. In addition to these goods there were also on hand large quantities of rugs, carpets, figs, dates, and other typical Turkish commodities. The following lines are in most demand at present in the local market: Cotton cloth, plain and gray colors; thread, black and white; cheaper grades of cotton and flannel underwear, skirts, socks, stockings, all colors rather fancy; burlap or jute sacks and sackings; sugar; rice; spices—pepper, nutmegs, mustard, etc.; standard medicines and drugs—castor oil, soda, quinine, cream of tartar, bandages, hospital supplies, etc.; shoes for men, women and children; cheaper grades of ready-made clothing, chiefly smaller sizes for men, women and children; cheaper grades of hardware—wire nails, horseshoe nails, horseshoes (small sizes), screws, saws, etc., spades, shovels, picks, axes; new graphophone records and needles; toilet articles, perfumery, etc.; tinned and bottled fruits and vegetables, agricultural implements and dyes.

With the prevalence of high freight rates, subject to many alterations, American exporters should quote their prices c.i.f. Smyrna as local merchants are less well situated to follow fluctuations in freight rates than the American exporters. For the present at least exporters should require payment in dollars or in sterling exchange.

It would seem important that a regular steamer service be established between the United States and Piraeus (Greece), Algiers, Malta, Saloniki, Smyrna, Constantinople, and all Eastern Mediterranean ports, as the competition is very strong for this trade. For homeward cargoes, under ordinary circumstances, the exports would be whitestone (granulite), chrome, emery stone, dried fruit, hides, bayleaves, olive oil, olives, marble, tobacco, opium, carpets, licorice root, sponges, and sulphur oil; and vessels must complete loading with fresh grapes from Almeria, Spain, in September and October, and oranges and lemons from Sicily in other months.

The International Mercantile Marine Company announced on August 29 the establishment of a new trans-Atlantic passenger and freight service from New York via Constantinople to Constanza, Roumania, which shall afford easy access to points in the Far East and in the Black Sea region.